AUTOMOBILE ENGINEER

DESIGN

PRODUCTION

MATERIALS

Vol. 49 No. 11

NOVEMBER 1959

PRICE: 3s. 6d.

The most powerful surface grinder in its class!

LSS82 Grinder —
a multi-purpose
machine



Surface grinding operations wi



Cutting a water pipe with high



Cleaning with wire brush.



High speed cleaning with hub wheel.

This expertly designed, heavy-duty surface grinder, with a high-efficiency vane-type air motor, gives you greater power than any other surface grinder in its class. An exceptionally high airflow efficiency has given this model a 35% power increase over its predecessor. Yet for all its power it weighs only 11 lbs.

This grinder is extremely versatile. Fitted with flared

cup wheels, it can be used for cleaning castings and other surface grinding operations; with cut-off wheels attached, it can cut all types of metal, ceramics and stone! Wire brushes can be fixed to clean furnace scale, rust or paint from all large surfaces, and many high-speed cleaning jobs can be done by fitting hub wheels.

Atlas Copco

PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent, or write to

Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Limited, Maylands Avenue, Hemel Hempstead, Herts.



How to produce a first-class brake liner is certainly no puzzle to B.B.A. Over fifty years of experience, backed up by one of the most up-to-date Research and Development Laboratories in the country ensures that MINTEX High Performance Brake Liners are consistently second to none.

The pattern of research and testing at B.B.A. fits smoothly together to solve the braking problems of the present and to be ready with the answers for problems of the future.

That's why we say with confidence

You can rely on

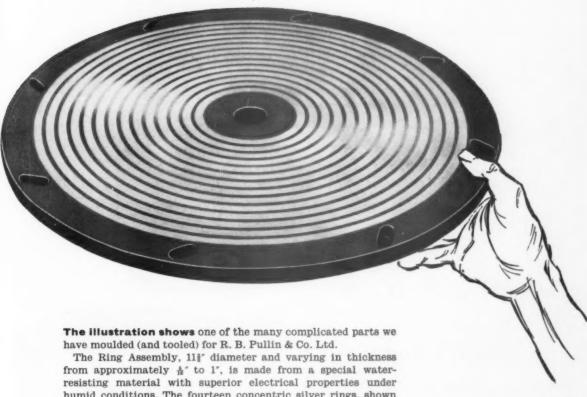
MINTEX

HIGH PERFORMANCE BRAKE LINERS

MINTEX BRAKE AND CLUTCH LINERS AND DISC BRAKE PADS ARE MANUFACTURED BY BRITISH BELTING AND ASBESTOS LIMITED. CLECKHEATON YORKSHIRE

Metropolitan Plastics

Specialists in Thermo-setting Plastics



humid conditions. The fourteen concentric silver rings, shown moulded in position, are so costly that rejects had to be avoided and, indeed, they were.

This is not an exceptional case. The design, tooling, moulding and processing of thermo-setting plastics components, large or small, simple or complicated, few or many, is part of our normal daily routine. Our prices are reasonable, our quality superb, our promises meticulously kept.

Why not consult us with your plastics problems?



METROPOLITAN PLASTICS LTD

GLENVILLE GROVE, DEPTFORD LONDON SES

Telephone: TDeway 1172

KIRKSTALL AXLES

FOR

LI

TRUCKS
DUMPERS



EARTH MOVERS

FORK LIFT TRUCKS





MOBILE CRANES

KIRKSTALL FORGE ENGINEERING LIMITED LEEDS, 5

Telephone: Horsforth 2821



B. O. MORRIS LTD. . MORRISFLEX WORKS, BRITON ROAD . COVENTRY

Telephone: 53333 (PBX)

Telegrams: MORISFLEX, COVENTRY

PRODUCT OF THE MOVEMEN GROUP

Tough as the rock

COR-TEN CAN TAKE IT



Super-tractor shovel shifting rocky overburden (Photograp's by courtesy of Michigan (Great Britain) Limited)

WHEREVER you see steel taking savage punishment, the chances are it will be SCW Cor-Ten from The Steel Company of Wales.

With good reason. For over the past four years SCW Cor-Ten has built up a solid reputation for sheer toughness. More and more designers and users are specifying SCW Cor-Ten where high yield strength and corrosion and abrasion resistance are of major importance.

Cor-Ten is tougher

- Weight for weight, the yield strength is 50% higher than ordinary mild steel alternatively: Strength for strength, a saving of \(\frac{1}{2}\) of the weight is possible
- 4-6 times more resistant to atmospheric corrosion
- Highly resistant to abrasion and fatigue

Please write to us at the address below for further information or for technical assistance in the application of SCW Cor-Ten to your products

Cor-Ten



RAILWAY ROLLING STOCK
AGRICULTURAL AND EARTH-MOVING EQUIPMENT
MINE CARS · POWER STATION INSTALLATIONS
BARGES AND SMALL CRAFT

THE STEEL COMPANY OF WALES LIMITED

ABBEY WORKS, PORT TALBOT, GLAMORGAN TELEPHONE: PORT TALBOT 3161

On the SUNBEAM 'RAPIER'

Lockheed disc brakes

contribute their outstanding

performance to that of this most attractive car,

bringing powerful and consistent braking.

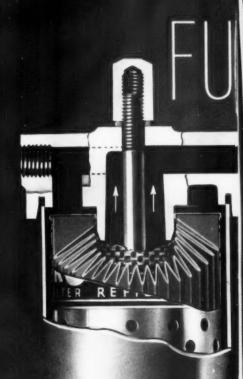
LOCKHEED

DISC BRAKES

LOCKHEED HYDRAULIC BRAKE COMPANY LTD.
LEAMINGTON SPA, WARWICKSHIRE, ENGLAND



ONE OF THE AUTOMOTIVE PRODUCTS GROUP



PUR

MICRONI

AUTOMOTIVE PRODUCTS COMPANY LTD.

THE ORIGINATORS OF THE

AIR

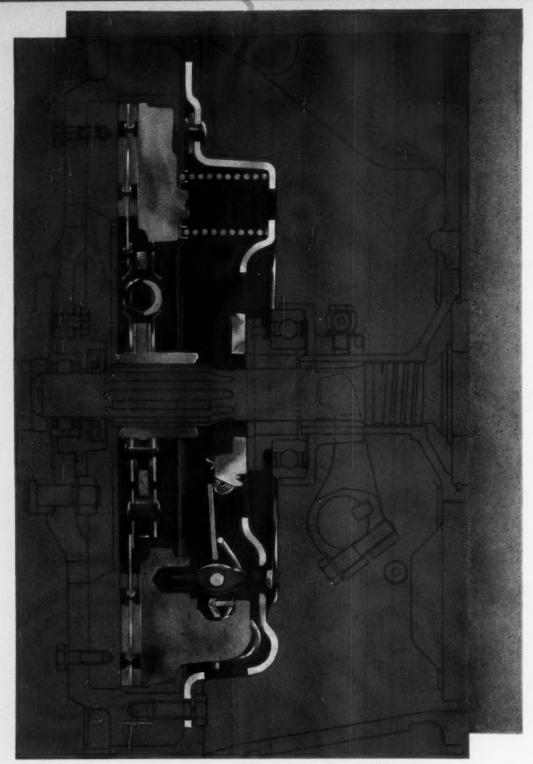


FILTERS

amington spa, warwickshire, England dlator, micronic

PAPER FILLE

ONE OF THE AUTOMO IN



On the ALBION

'CLYDESDALE' 14-TONNER

THE 14" A.S. STRAP-DRIVE CLUTCH, BY

BORG & BECK REGO TRADE MARK

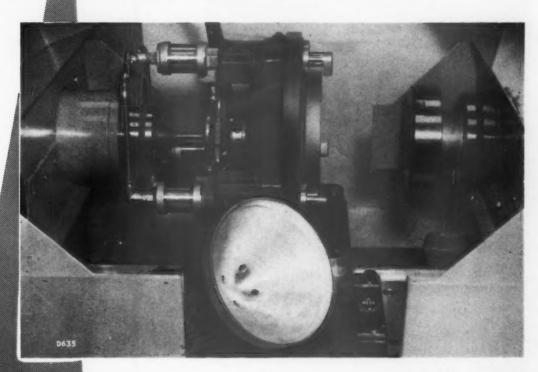
BORG & BECK COMPANY LTD., LEAMINGTON SPA, WARWICKSHIRE



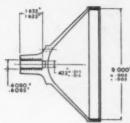
ONE OF THE PRODUCTS

simultaneous boring from opposite ends on a British Made

model 222 HEALD BORE-MATIC



Boring and facing, from opposite ends, a spin can base at one setting. Cycle is fully-automatic after loading. Stock removal .060" (8" diameter) and .010" J.012" (.608" diameter), cutting speed 1,250 ft. per min. (8" diameter) and 580 ft. per min. (.608" diameter); feed .005" boring and .001" The boring heads, tooling and fixture arrangement can be duplicated to double output.



it pays to install **HEALD** machines

Heald Bore-matic Models 221, 222, 321, 322, 421 and 422 are built in

this country.

Our specialists are available to discuss their suitability and we will quote for machines with tools, jigs and fixtures to suit components and required production.

HERBERT

LTD., COVENTRY Factored Division, Red Lane Works.



AD.486



QUALITY
STEELS
FOR ALL
INDUSTRIES



WRITE FOR LITERATURE AND STOCK LIST

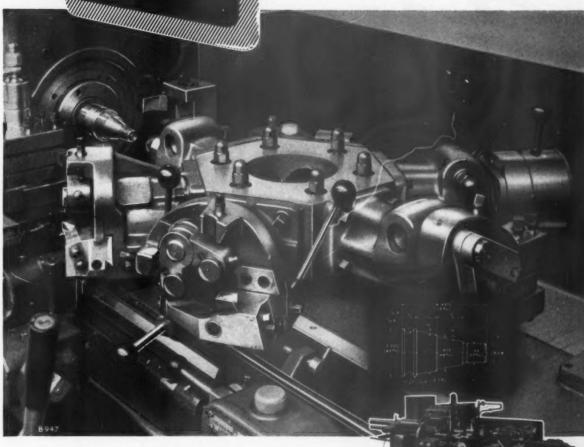
SHEFFIELD FORGE & ROLLING MILLS CO. LTD.

TELEPHONE (& LINES) SHEFFIELD 24274 MILLSANDS, SHEFFIELD 3

TELEGRAMS : SHEFFORGE SHEFFIELD

TELEX NO. 54-215





Standard tooling, including Chipstream Boxtools and Coventry Dieheads, is used to produce the component illustrated from 21 dia. mild-steel bar in a total time of 4 mins. 30 secs.

. . . No. 5 Senior Preoptive Capstan Lathe

Accommodates bar work up to 21/2" diameter or chuck work up to 151/2" swing.

Sixteen-speed power-operated "Preoptive" headstock, ample power to the spindle throughout the entire speed range from 21-1,500 r.p.m.

Automatic sliding and surfacing saddle with or without chasing mechanism. Feeds to saddle reversible independently of those to the capstan slide.

Turret is automatically clamped at commencement of forward travel of the capstan slide and is of hollow construction thereby permitting bars to be passed through when necessary. Leader control to capstan slide also available if required.

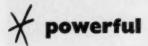
Most Herbert Capstan and Combination Turret Lathes are now available for early delivery

HERBERT LTD., COVENTRY Factored Division. Red Lane Works.

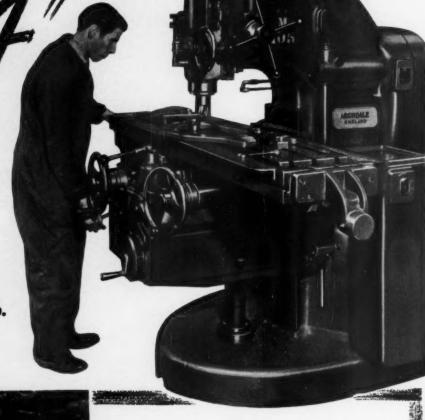


VERTICAL





CUTS COSTS AT FORGROVE MACHINERY CO., LTD.





JAMES ARCHDALE & CO. LTD.

Regd. Office: LEDSAM ST., BIRMINGHAM 16.
Telephone: EDGbaston 2276 Works: BLACKPOLE WORKS, WORCESTER.
Telephone: Worcester 27081

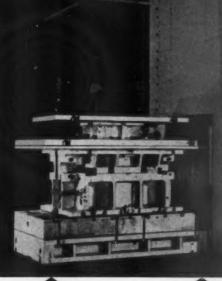
A Member of the Staveley Cool & Iren Co. Limited Group Sole Agents: ALFRED HERBERT LTD., COVENTRY.
Telephone: Coventry 89221

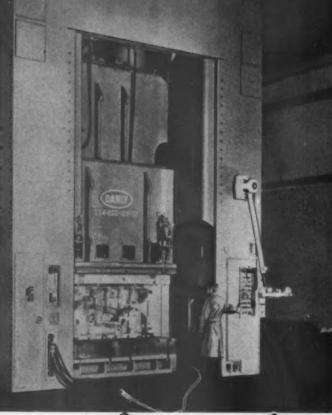
This massive, powerful and versatile machine makes light work of heavy duty milling on a variety of jobs at Forgrove Machinery Co. Ltd., Leeds.

Table has reversible automatic feeds and quick power traverse in all three directions. Speeds and feeds changed from front of machine. Direct reading dials. Twelve speeds from 29/520 r.p.m. or alternatively 36/638 r.p.m. Twelve feeds, #" to 20 in. per minute. Quick and fine hand adjustment to spindle. Table working surface $53'' \times 144'$.



DANLY QUICK DIE CHANGE **PRESSES**





Make die change a matter of minutes

Offer greater production from lesser number of presses.

All types: single, double, triple action.

Any tonnage or size specified within transportation limits.

DANLY MACHINE SPECIALTIES, INC., Chicago 50, Illinois U.S.A.

SELLING AGENTS IN GREAT BRITAIN : GASTON E MARBAIX LTD

DEVONSHIRE HOUSE . VICARAGE CRESCENT . LONDON-S. W. 11

Danly Presses are built in the United States and United Kingdom



There is no substitute for a C.A.V. Paper Filter

Where else can you find a filter of such high efficiency with adequate service life? The C.A.V. fuel oil filter removes from the fuel a high proportion of the minute abrasive particles which wear the finely fitting parts of fuel injection pumps and injectors, and which pass through many filters. But with high efficiency it is inevitable that the filter element will become choked in time—its life depends largely on the effective filtering surface area. In the C.A.V. filter, this is 560 sq. inches—several times more than most other types, ensuring the longest life commensurate with adequate filtration.

Great care is taken in testing and checking C.A.V. paper filter elements during manufacture. Substitutes are frequently faulty and are no safeguard to fuel injection equipment.

WHY TAKE RISKS? The C.A.V. element is low in price — insist on the genuine article





Manufacturers of

ELECTRICAL & FUEL INJECTION EQUIPMENT C.A.V. LIMITED, ACTON, LONDON, W.3.

AP 948

Get down to..

Earth

Our technical and development team has its feet firmly on the ground although moving forwards and upwards with every engineering development.

For the past 60 years many barriers to progress have been overcome on land, sea, and in the air. Hoffmann bearings share in these triumphs

BALL AND ROLLER BEARINGS by

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

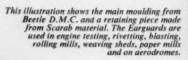


Here's a typical example of how the mechanical strength of Beetle D.M.C. (Dough Moulding Compound) helps to solve industrial problems.

These ear defenders are used to protect the hearing of workers in proximity to jet engines and in noisy factories. During the development work by the makers, Dennis Ferranti Meters Ltd., twelve sets moulded from conventional materials were delivered to Bomber Command for testing. The report of The Central Medical Establishment, Acoustics Laboratory, was that the ear defenders gave excellent protection, but that the mouldings then used were considered too fragile.

D.M.C. mouldings were substituted and have been found virtually indestructible.

D.M.C. is the ideal material whenever high mechanical and/or electrical strength is required. The material can be moulded in conventional compression presses on short cure times and at low pressure. We shall be glad to send full technical details.







MOULDING POWDERS

B.I.P. CHEMICALS LTD., Oldbury, Birmingham. Telephone : Broadwell 2061. London Office: 28, Haymarkec, S.W.1. Telephone: Trafalgar 3121



THE ALL-NEW ANGLIA

by



As major suppliers of rubber/metal units,
Silentbloc Ltd. and their subsidiary,
Andre Rubber Company Ltd.,
are proud to be associated
with the ALL-NEW ANGLIA,
and wish Ford Motor Company Ltd.,
every success
with this impressive new model.

SILENTBLOC

and

ANDRE RUBBER



SILENTBLOC LIMITED MANOR ROYAL CRAWLEY SUSSEX ANDRE RUBBER COMPANY LIMITED KINGSTON BY-PASS SURBITON SURREY

more & more people



buy



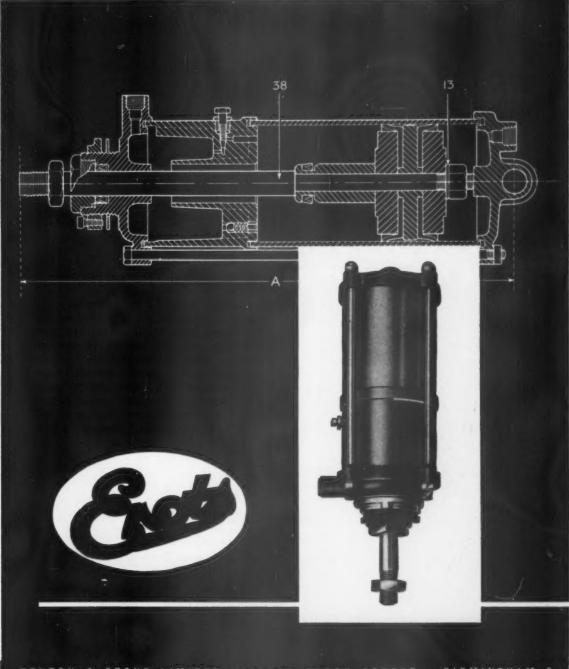
ECLIPSE HIGH SPEED STEEL

24 TEETH

THE REAL PROPERTY OF THE PARTY OF THE PARTY

*Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

New and Improved



BENTON & STONE LIMITED · ASTON BROOK STREET · BIRMINGHAM 6



- *** COIL SPRINGS**
- * TORSION BARS
- * LAMINATED SPRINGS

also

* UPSET

FORGINGS

TOLEDO WOODHEAD SPRINGS give top performance everywhere

TORSION BARS



also UPSET FORGINGS

As vehicle suspension engineers we design and manufacture or supply to requirements all types of springs used in automotive design.

We are also the manufacturers of

KANTINK SPRING WASHERS

> LAMINATED SPRINGS

TOLEDO WOODHEAD SPRINGS LIMITED SHEFFIELD 3

TWS48

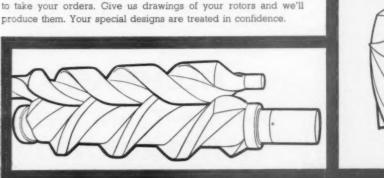
Giant rotors... baby rotors...

and all sizes in between

At last the difficulties of manufacture are out of the way. With our latest equipment and tools, developed over recent years, we are now regularly producing many varieties of high lead angle rotors for pumps, compressors, blowers and meters.

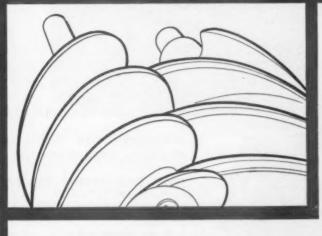
Accuracy of thread form and spacing is exceptionally good and we can deal with most practical sizes. Diameters may be from one inch up to 32 inches-face widths up to 48 inches-helix angles between 30 and 60 degrees-right or left hand. Lobe combinations may be 2/2, 2/3, 3/4, 4/6 or 6/8.

Our practical experience is here for you to use-and we're ready to take your orders. Give us drawings of your rotors and we'll









Holroyd

90 YEARS OF GEARS John Holroyd & Co. Ltd. Milnrow, Lancashire.

PROLONG FATIGUE LIFE BY SHOT PEENING

Here is a less publicised but most important application of the Wheelabrator Airless Shot system. The operation is shot peening, the component, the rocker arm of a 3 cylinder 2 stroke diesel engine; and the process: treating the inner arches so as to strengthen the outer fibres against direct stresses. Messrs. Tilling Stevens Ltd., of Maidstone, extend the fatigue life of these highly stressed components by submitting them to 3 minutes under a blast of S.320 cast steel ball shot. Much research has proved the superiority of Wheelabrator cast steel ball shot for many such processes and adequate stocks are carried to offer immediate delivery of all grades.

TILGHMAN'S Rotary Table Airless WHEELABRATORS

Tilghman's also supply:

WHEELABRATOR—Airless Centrifugal Cleaning Equipment.

PRESSURE OPERATED SHOT BLAST PLANTS—Cabinets, Rotary Tables, Rooms, Tumbling Barrels.

DUST EXTRACTION EQUIPMENT—including plants for hot and corrosive gases up to 500°F.

ELECTRIC FURNACE HOODS—for complete control of fume from the Furnace.

AIR COMPRESSORS—all types and sizes up to 6000 cfm., pressures up to 1000 lbs. sq. in.

VACUUM PUMPS up to 8000 cfm displacement.

FOUNDRY CONVEYING SYSTEMS.

PNEUMATIC TOOLS.

ALL ABRASIVES AND EQUIPMENT.

TILGHMAN'S LIMITED BROADHEATH ALTRINCHAM CHESHIRE

A member of the Staveley Coal & Iron Co. Ltd. Group LONDON OFFICE: 1 Chester Street, S.W.1

AGENTS:

MIDLANDS: R. J. Richardson & Sons Ltd., Commercial Street, Birmingham 1 SCOTLAND: Balbardie Ltd., 227 Bath Street, Glasgow C.2; 110 Hanover Street, Edinburgh 2 NORTHERN IRELAND: Stewart Industrial Services Ltd., 129 Ormeau Road, Belfast.

W.247

Automobile Engineer, November 1959





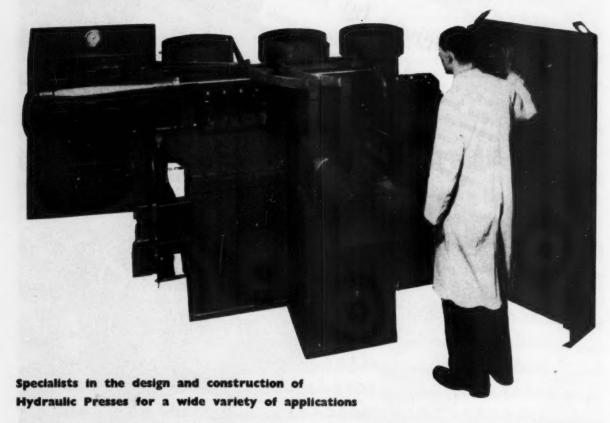


FOR GEARS

E.N.V. ENGINEERING CO. LTD., HYTHE ROAD, WILLESDEN, LONDON, N.W.10. Tel.: LADbroke 3622



Special Presses for high-output production



Hi-Ton specialise in the design and manufacture of individual hydraulic presses for operation in mass production lines. The example illustrated has recently been supplied to an automobile manufacturing company and inserts three core plugs into the cylinder block, the plugs being fed to the rams by independent hoppers. The cylinder blocks are transferred automatically in and out of

their operating position. The time cycle of this machine is 45 seconds.

A range of standard Hi-Ton Hydraulic presses is available with minimum pressures from 1 to 300 tons and whatever your presswork requirements in this range it will be worth investigating the application of a special or a standard Hi-Ton machine.



Sales and Service for

the British Is

DRUMMOND-ASQUITH LIMITED

KING EDWARD HOUSE, NEW ST., BIRMINGHAM Phone: Midland 1431. Also at LONDON Phone: Trafalgar 7224 & GLASGOW Phone: Central 0922



IN-LINE TRANSFER MACHINE FOR Fustin CYLINDER BLOCKS

This Asquith 14-station in-line transfer machine provides, among other operations, for semi-finish and finish boring crankshaft and camshaft bores; boring and facing a recess for the oil pump; milling thrust bearing faces on the central crankshaft bearing and reaming the crankshaft and camshaft bores. A split liner bush is also pressed in and fine bored in position.

WILLIAM ASQUITH LTD.

HALIFAX · ENGLAND





Hydraulically operated pressing station for inserting liner bushes.

Two 3 h.p. Asquith Unit Heads which finish ream the crankshaft and camshaft bores.

Sales and Service for the British Isles

DRUMMOND-ASQUITH LIMITED

KING EDWARD HOUSE, NEW ST., BIRMINGHAM Phone: Midland 3431, Also at LONDON Phone: Trafalgar 7224 & GLASGOW Phone: Central 0922



One man and one hundred nuts

How long should it take him to fix them?

According to accepted engineering practice* it would take a worker as long as 197 minutes to assemble 100 5/16" slotted nuts and split pins. Yet the same man would take a bare 40 minutes to assemble an identical number of Simmonds 5/16" Nyloc self-locking nuts.

Common sense says that it pays to use Simmonds self-locking nuts every time when assembly costs run as high as they do today. In fact, with average labour costs and overheads, there are savings of over 42- on every hundred assemblies—and over £2,000 on every hundred thousand assemblies. Why not call in Simmonds to carry out a completely thorough costing of your assembly operations.

Our 16 mm Nyloc colour film is available for showing in your factory.

All times are based on the Haddon & Genger Standard Data (1955) Handbook. Costs include wages at 5/- an hour and overheads at 250%.



time saved is money saved

SIMMONDS SELF-LOCKING NUTS

SIMMONDS AEROCESSORIES LTD · TREFOREST · PONTYPRIDD · GLAMORGAN

A member of the Firth Cleveland Group

Branches: London, Birmingham, Manchester, Glasgow, Stockholm, Copenhagen, Ballarat, Sydney, Johannesburg, Amsterdam, Milan, New York, Mannheim and Brussels

CRC 43N



WHEN YOUR CAR STARTS LIKE MAGIC

-he's the magician

WHEN YOU run on BP Super Plus, your car starts first time and warms up rapidly to give brilliant all round performance—quicker acceleration, better response, smoother, cleaner running. Why? Because BP Premium Petrols (BP Super Plus and BP Super) are the most tested petrols in the world.

The amazing superiority of BP Premium Petrols is solidly based upon way-ahead technical research. At the remarkable BP Research Centre at Sunbury-on-Thames, scientists like Graham Mead, shown in the picture, work incessantly to ensure that BP Premium Petrols will get really peak performance out of any car on the road.

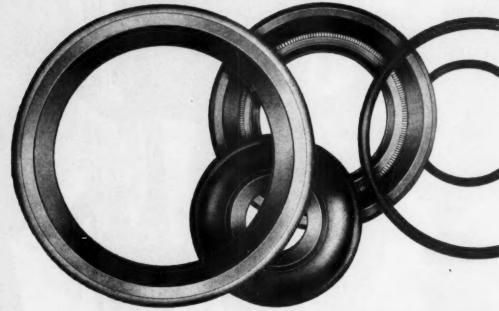
For your own satisfaction, get at the facts behind petrol today. Send off for a copy of the strikingly illustrated FREE booklet "Behind Every Pint of BP Petrols" which tells you many of the secrets of Sunbury. All you have to do is to fill in and post the coupon on the right. Do it straight away.

WHAT'S GOING ON IN THE PICTURE?

Graham Mead, a Senior Analyst at Sunbury, operates a 'vapour-liquid ratio' apparatus. This is used to give accurate measurement of the volatility – or vapourizing rate – of petrol. It's scientifically correct volatility that enables BP Premium Petrols to give first-time starting. (This vapour-liquid ratio apparatus was invented at Sunbury.)

To BP, 6/8 Ludgate Hill, Lon	don, E.C.4
Please send me a copy of the FF "Behind Every Pint of BP Petrols."	REE Bookle
Name	
Full Address	BP

SuPerfectability in Sealing











To meet the exacting and varied demands of industry and transportation a wide range of oil seals and hydraulic packings is available. The experience gained in research, development and manufacture over nearly 30 years qualifies this company's claim to provide the perfect seal for any need. Each type of seal has special characteristics which determine its suitability for a specific application. Extreme temperatures, high shaft speeds and resistance to chemicals and fluids are among the many conditions of service which must be considered. As manufacturers of all types of seals in different materials, we are in a unique position to give sound advice based on the widest

Our latest catalogue will soon be available. May we reserve a copy for you, or may one of our technical representatives call and help you?



possible experience.

SUPER OIL SEALS & GASKETS LIMITED, KINGS NORTON FACTORY CENTRE, BIRMINGHAM, 30

Top men, Shop men,

fast-coming-up-men

For weldability call for Group 2

But Group 3's slag removal

Earns the welder's approval;

They're combined

VELVARC TWO

in the new. . .



Write for electics of the full state of ACTARS, arriving transferences on place, writing electroses for all furnishes and validate accessives.

ACTARC

the name for dependable electrodes

ARG MANUFACTURING CO. LTD.



DU PONT neoprene PARTS IN THE ROVER 3 LITRE

Rover's famous 3 litre is an outstanding example of the way Du Pont neoprene also plays a part in Britain's go-ahead motor car industry. Du Pont neoprene applications include: steering hose, brake diaphragms, wire coverings, lamp gaskets, suspension dust boots, protective coatings and adhesives. Automobile engineers are doing many interesting things with neoprene, Du Pont's versatile synthetic rubber. They specify neoprene because it offers balanced resistance to all the causes of deterioration—including petrol and oil, ozone, sunlight heat and weather. And because it can be compounded and formed in many ways, to perform many specialized functions supremely well. Du Pont neoprene can be utilized in more ways than you may have realized. For a copy of the Du Pont Elastomers Notebook, featuring new developments with Du Pont neoprene, send us the coupon below.

DISTRIBUTORS Du Pont Company (United Kingdom) Ltd, 76 Jermyn Street, London, S.W.1



neoprene

BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY

Du Pont Company (United Kingdom) Ltd. Room 533, 76 Jermyn Street, London, S.W.I., England. Please send me a copy of the Du Pone Elastomers Notebook. I am particularly interetted in

NAME
POSITION COMPANY
ADDRESS
CITY COUNTRY

Good braking starts.

... and ends with FERODO

Anti-Fade Brake Linings

ALWAYS SPECIFY FERODO FRICTION MATERIALS

FERODO LIMITED . CHAPEL-EN-LE-FRITH A Member of the Turner & Newell Organisation

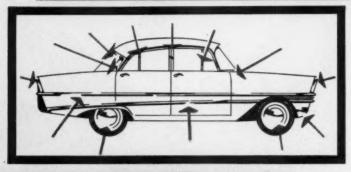
For the brilliance that lasts and lasts . . .

TRUBRITE
Stainless Steel

the car trim of to-day and of the future



Trubrite keeps its beauty so much longer than other trim materials, and saves me work in cleaning. It resists scratches, never corrodes, and maintains the value of my car.



THE DEALER says:

Trubrite, with its time-proof brilliance, strength, and easy maintenance, makes an instant appeal in the showroom. It also helps me clinch those vital marginal sales.

Sparkling beauty enhances styling of modern cars Cannot rust, peel or chip. No pitting.

More strength—resists scratches and denting.

Bright right through.

Easy to clean (using only soap and water)

Time-proof brilliance keeps up value of car.

Already adopted for many parts both outside and in by leading manufacturers, such as Vauxhall, Morris, Wolseley, Riley, etc.



ARTHUR LEE & SONS LIMITED

TRUBRITE STEEL WORKS 'MEADOW HALL 'SHEFFIELD 'Telephone: Sheffield 387272 London Office: Stafford House, 40/43 Norfolk St., Strand, W.C.2. Tel: Temple Bar 7187/8 Birmingham Office: 191 Corporation St., Birmingham 4. Tel: Central 6801/2

THE SMALL CYLINDER ACTUAL SIZE THAT DOES A BIG JOB

To meet the demand for a small. powerful and compact air cylinder Schrader's have added to their already representative range a new midget type. This is a double-acting cylinder of 1" bore, with a neck mounting thread for easy assembly in any position. The cylinder and piston are of non-corrodible brass and the general construction is designed to give long trouble-free service under fast, arduous conditions. It is ideally suited for operating jigs and fixtures, transfer and special purpose machines. This cylinder can be supplied from stock with the following piston strokes, 1", 2", 3", 6", 9" and 12".

Compact overall size permits mounting in the minimum space.

Popular 1º dia. neck mounting thread complete with lock nut. Fits standard 1" dia. bored holes.

Cartridge type bronze bearing and piston rod seal, replaceable without dismounting cylinder.

Synthetic rubber "U" cup piston seals-self adjusting.



AIR CYLINDERS

To: A. SCHRADER'S SON, Air Control Products Dopt. AE, 829 TYBURN ROAD, ERDINGTON, BIRMINGHAM, 24

Please send details of Schrader Midget Air Cylinders

20



TELEPHONE: WALLSEND 64551 . TELEX: ANGUS N/TYNE 53-254 . TELEGRAMS: 'GACO' WALLSEND.



Interchangeable, on the same mounting, with the standard Marles manual gear unit.

type 4
'Universal'
powersteering
gear

This latest type 4 unit embodies the wide experience of Marles in power-steering, and consists of a 2-valve box mounted on the top of the standard Marles 861 manual gear unit.

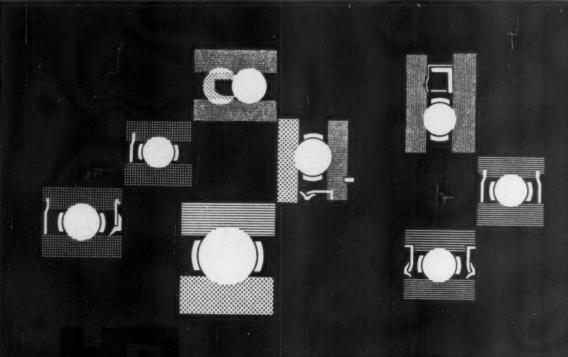
The type 4 Universal unit shown above, the type 3 Universal unit and the standard manual unit are all interchangeable on the same mountings.

Further particulars will be sent on request.

ADAMANT ENGINEERING CO. LTD., THE AERODROME, WOODLEY, Near READING.

Sole proprietors of the Marles Steering Company Ltd.
Telephone: Sonning 2351
Telegrams: Adament Reading

MARLES



R&M RIGID BALL JOURNALS

Very first and roller begoings derig and Age to disease every spend, books and assistant

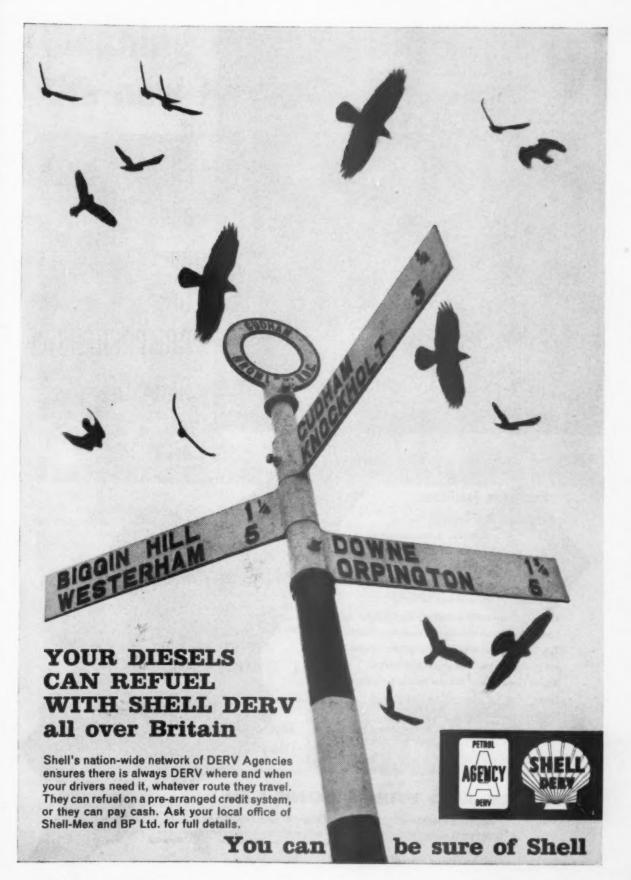
- Trementland adaptability for specific leads co
- Of the range of four duties during by very lar
- tone
- Ability to personate for elight errors to
 - alignators
 - Verticions available for particular application
 fixed with some or two shirted or scale; not class
 trings for the eased capacity; some stage for location proposing a variety of special material for high special



RANSOME & MARLES BEARING COMPANY LIMITED

NEWARK-ON-TRENT • TELEPHONE 456 • TELEX 37-626

BRANCHES • OFFICES AND AGENCIES THROUGHOUT THE WORLD





it
all
adds
up
to
COMPREHENSIVE
SERVICE

Up-to-date Plant and Production Facilities...

Truly comprehensive service involves the ability to supply all needs: in addition to outstanding facilities for production,

FORGINGS AND PRESSWORK LIMITED offer—
Design Consultation and Technical Advisory Service Metallurgical Control of Raw Materials
Heat Treatment under Laboratory Supervision
Constant Vigilance and Modern Inspection Equipment.
This Company participates in the technical, research, and productive resources shared by the whole
Birfield Group, which includes famous firms such as
Hardy Spicer Ltd. Laycock Engineering Ltd.
Salisbury Transmission Ltd.,
and other Companies well known in light engineering.

Enquiries to:

FORGINGS AND PRESSWORK LTD

BIRCH ROAD · WITTON · BIRMINGHAM 6 · Phone: Birmingham East 1262-7

Member of the Birfield

- WW C

Birfield Industries Ltd., Stratford House, London, W.1

Cleaning component parts for the new Hoover Junior Cleaner



At the highly mechanised Hoover Factory at Perivale in Middlesex a Dawson metal cleaning and degreasing machine plays an important role in the efficient production line for the new Hoover Junior cleaner. The illustration above shows how the three diecast components converge ready for washing. The two smaller components come from the bottom left and the housing comes down the chute from the top left.

This is only one of the countless applications for the Dawson metal cleaning and de-greasing machines which are widely used in every grade of engineering from electric shaver components to heavy diesel cylinder blocks.

A catalogue giving full details of these machines can be sent, on application, from

Drummond-Asquith (Sales) Limited at the address given below.

Machines for cleaning large and small articles



DEGREASING AND CLEANING PLANT

Sole Distributors DRUMMOND - ASQUITH King Edward House, New St., Birmingham

Tel. Midland 3431

Manufacturers:

Dawson Bros. Ltd., Gomersal, Near Leeds. Tel. Cleckheaton 3422 (5 lines) London Works, 406 Roding Lane South, Woodford Green Essex. Tel: Wanstead 7777 (4 lines

BHB PISTONS -



A driving force in industry for over 36 years



BHB Pistons have been supplied to vehicle engine builders since 1926. Manufacturing techniques have improved, higher operative standards have been achieved; only the outstanding quality of BHB Pistons has remained unchanged over the years.

Manufactured by
Automotive Engineering Ltd.

Automotive Engineering Ltd.

(One of the Sheepbridge Engineering Group)

The Green, Twickenham, Middlesex.

Telephone: POPesgrove 2206/9 Telegrams: MOTIF, Twickenham



ONTENTONG ONTENTONG ONTENTON ONTENTON GNOKET NIATERIALS

DISTRIBUTORS OF MATERIAL IN BULK IN GT. BRITAIN

J. A. NORDBERG LTD

171 QUEEN VICTORIA ST LONDON, E.C.4 Tel: Central 9678

FOREIGN & COLONIAL ENQUIRIES TO H. JACKSON LTD

OAKENCLOUGH, GARSTANG Nr. PRESTON, LANCS. Tel: Garstang 3308

PROUP

SDF CINGS

OF THEIR

SMETHWICK DROP FORGINGS LTD

SMETHWICK & KIDDERMINSTER

Tests of Quality





successes with pistons & rings by



THE BRITISH PISTON RING CO. LTD., COVENTRY, ENGLAND

Major	Events-	lanuary to	Auguer	1050

DATE	MEETING	RESULT
Jen. 10th	New Zealand Auckland Grand Prix	Cooper-Climen 1st, 2nd, 3rd.
nn 25m	Monte Carlo Relly: Charles Faroux Trochy: Class Award over 2,000 cc.; Copp des Danes.; A A C. Challenge Trochy; Class Award up to 1,000 cc.	Jaguar 3-car team, Jaguar 1st & 2nd, Austin A.40 1st, Austin A.40 1st, Austin A.40 2nd,
Feb. 7th	Non Zeeland, Teresonra Race	Cooper-Climax for & Jed.
Fob. 8th	Cause: Winter Relly, Ladies Cup	Austin A.40.
Fon 26ch	Italy: Sestriore Rally: Touring Care \$00.1,000 sc. Touring care over 1,600 sc.	Auxtin-Healey Sprice Sec. Jaguer 3-4 Sec.
Mar. 15th	France, Lyan-Charbonieres Rally: Ladies Cup	Austin A 40.
Mar. Mar	U.S.A. Sebring: Touring Care Class 4	Austin-Healey Spring for, 2nd & 3rd
Mary 30sh	frederid Internacional Rally: Ladies Trochy	Morris Minor 1000.
Mar. 30th	Goodward: Lavant Cup -Sussex Tropby - Freduction Salson Car Race	Cooper-Climas (ss. Lister-Jaguar, 1st & 2nd, Jaguar 3 4 (st. 2nd & 3rd
Mar. 10sh	Mallory Park : Sports Cars over \$,200 cc. : Formula Libro.	Lister-Jaguar 3 4, fac. Lister-Jaguar 3 4, fac.
Apr. 11th	Oulton Park : Beleish imaire Trophy.	Conser-Climax, 2nd, Conser-Monsco, 1ss, Louis-Climax, 3rd, Liner-Jaguar, 4th.
Apr. 19th	Aintrea - 1 horts Care even 1,100 gc 1 2,000 cc Cher - Selone Car Roce 2 Sevenil Roce Selone Care 1,600-2,600 cc	Locus-Christa Zod. Licer-layuer, Zod. Licer-layuer, Zod. Locus-Christ, Tie. Coopen-Christ, Tie. Lopus 3 4, Tet, Zod & Zod. Laguer 3 4, Tet, Zod & Zod.
Apr. 28th	Italy, Systems Grand Prive Roymula 2	Copper-Climax 3rd.
May 2nd	Holland, Talig Rally, General Classification Class Fr over 3,800 cc.	inguar 3 4, fee. Jaguar 3 4, fac & 2nd.
May 2se	Shortenan Insuracional Trophy, Formula 2 Sport Cari, 2,000-1,000 cc. Sport Cari, 2,000 cc. Sport Cari, 2,000 cc. Sport Cari, 2,000 cc. Sport Cari, 2,000 cc. Production Touring Cari, Canaral Class Production Touring Cari, Cari, 1,300-1,600 cc. Sport Cari, 1,300-1,600 cc. Sport Cari, 1,300-1,600 cc.	Conner-Glainty, 512 & 3rd, Linear-Japane, 3rd, Cooper-Genacy 1st, Linear-Claime, 2rd & 3rd, Japane 3 4, 5st, 2rd & 3rd, Higner 3 4, 5st, 2rd & 3rd, Higner 3 4, 5st, 2rd & 3rd, Higner 3 4, 5st, 2rd & 3rd,
May 10th	Manaco Grand Prix	Cooper-Climax, 1st & Sch.
Play 18th	Pau Grand Prix: Portpols 2	Cooper-Climax, 1st, 2nd &
May 24th	Targe Hasio: 1,100 st, Sports Class	Aussin-Henley Sprite 2nd
	Direct Grand Pris	Cooper-Climax, 2nd & 3nd, Laws-Climax, 4ch
July Sth	French Grend Prist, Applicat	Cooper-Climax 3rd
July 1864	British Grand Pale, Almaren Sports sans ever 2 lignes	Croper-Climax, 1st & 3rd, Limits Signar, 2nd, Ind &
	Sparra cara 1,400 oc se 2 litret	Lorse Climaz 1st A 3rd. Cooper Climax 2nd.
Aug. Thes	Percugases Grand Prin	Cooper Chines for A 2nd

RADATORS

for the small saloon...
or the large truck.....

- cooling specialists since motoring began

COVENTRY MOTOR FITTINGS

CO. LT

ESTABLISHED 1902

You parlez anglais?



Good. Back from Paris, just. Weeks of negotiations, patient, complex, cordial, triumphant. Le shake-hand. Le pat-back. Soit! A la vôtre . . .

All complete now. All sworn, sealed, stamped, signed, settled. All legal. The Party of the First Part (nous voilà partis) etc., the Party of the Second Part (la soirée au deuxieme) etc... the Party of the Third Part (la quidame qui danse a ladite soirée) etc... Whereas (considérant que)... Notwithstanding (assis)... As witness (que le ciel nous soit témoin) etc... All official.

Meaning? That Wilmot Breeden, offering their technical knowledge (savoir-how), have bought a major holding (force majeure) in famous French components company Autocoussin Dura S.A.!

Meaning that Britain (*l'intrépide Albion*) now has a foothold (assiette de pied) in the motor vehicle components side of the European Common Market (marché vulgaire, mais fort commode).

Vive la reine! Vive le commerce et la science des mécanismes! Vive la France! Vive la joie! Et long vive Wilmot Breeden whose locks, handles, window-winders, bumpers, over-riders, etc., virtually every British car roads today, etc., now whizzing about all over Europe etc.

A limited number of booklets containing advertisements in this series is available. Write to: Advertising Dept., Wilmot Breeden, Oxford Street, Birmingham 5.

WILMOT BREEDEN are at Birmingham: also at London, Manchester, Bridgwater, Glasgow, Melhourne, Toronto.

SYAND RES



- cooling specialists since motoring began

COVENTRY MOTOR FITTINGS

CO. LT

ESTABLISHED 1902

You parlez

anglais?



Good. Back from Paris, just. Weeks of negotiations, patient, complex, cordial, triumphant. Le shake-hand. Le pat-back. Soit! A la vôtre . . .

All complete now. All sworn, sealed, stamped, signed, settled. All legal.

The Party of the First Part (nous voilà partis) etc., the Party of the Second Part
(la soirée au deuxième) etc... the Party of the Third Part (la quidame qui danse
a ladite soirée) etc... Whereas (considérant que)... Notwithstanding (assis)...
As witness (que le ciel nous soit témoin) etc... All official.

Meaning? That Wilmot Breeden, offering their technical knowledge (savoir-how), have bought a major holding (force majeure) in famous French components company Autocoussin Dura S.A.!

Meaning that Britain (l'intrépide Albion) now has a foothold (assiette de pied) in the motor vehicle components side of the European Common Market (marché vulgaire, mais fort commode).

Vive la reine! Vive le commerce et la science des mécanismes! Vive la France! Vive la joie! Et long vive Wilmot Breeden whose locks, handles, window-winders, bumpers, over-riders, etc., virtually every British car roads today, etc., now whizzing about all over Europe etc.

A limited number of booklets containing advertisements in this series is available.

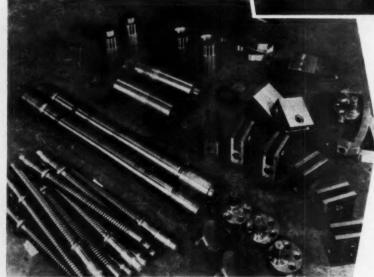
Write to: Advertising Dept., Wilmot Breeden, Oxford Street, Birmingham 5.

WILMOT BREEDEN are at Birmingham : also at London, Manchester, Bridgwater, Glasgow, Melbourne, Toronto.

Nitriding Steels

for all wear resisting applications





Typical examples of Nitrided Products.

These special steels have become firmly established as the most suitable for engineering purposes where maximum resistance to abrasion is required.

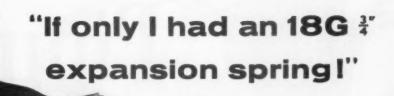
Nitriding steels offer the following advantages:---

- The best degree of surface hardness for a particular job.
- Minimum distortion during nitriding.
- Surface cleanness after nitriding with complete absence of scale.

by

BRIWN

ALLOY STEELMAKERS . FORGEMASTERS . STEEL FOUNDERS . HEAVY ENGINEERS









No. 757. Extra Light Compression, 1 gross Assorted, 1" to 18" diam., ½" to 2½" long, 27 to 19 S.W.G. 15/- each.

to 4" long, 22 to 18 S.W.G., 1" to 1"

6/6 each.



No. 388. 1 gross Assorted Small Expansion Springs. ‡" to 1½", 18G to 21G. sion Springs. 9/6 each.



No. 758. Fine Expansion Springs. 1 gross Assorted \(\frac{1}{2}\)" to \(\frac{1}{2}\)" to 2" long, 27 to 20 S.W.G. 15/- each.



No. 466. § gross Assorted Small Expansion Springs #" to 14" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each. There he is-stuck for a vital spring, the job hung up, all because he can't put his hand on the very thing needed to finish it. Don't be caught out like this-make practical use of TERRY'S BOXES OF ASSORTED SPRINGS where you'll find the exact spring you need for a thousand and one propositions. These handy boxes hold a wonderful variety of springs of every kind-compression, expansion, heavy, light, long, short, in the gauge you want -just when you want it. Why not let us send you our fully illustrated

HERBERT TERRY & SONS LTD

list of BOXES post free?

Redditch, Wores.

(Makers of Quality Springs, Wireforms and Presswork for over 100 years)



No. 1024. 20 Compression Springs 12" long. \(\frac{1}{2}" \) to \(\frac{1}{2}" \) diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansion 11" to 12" long, 5/32" to 1" diam., 22G to 16G.

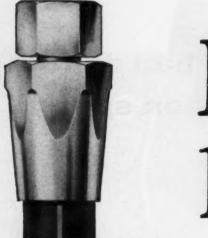
24/- each



Cut production costs with Terry Wire CIRCLIPS (Square Section)

We can supply from stock in sizes from \ to \ .

Have you a Presswork problem? If so let us have it and we'll help to solve it ★Interested in Springs? Ninth Edition of "Spring Design & Calculations" — post free 12/6



Piping hot

DUNLOP



..OR COLD

Piping water, oils, chemicals or air at all temperatures . . . piping for gravity flow or high pressures . . . piping for countless applications in countless industries can be supplied by Dunlop.

Among the comprehensive range of Dunlop flexible pipe assemblies are:

High Pressure Wire Braid Hose for hydraulically operated equipment • Automobile Industry Hoses • Car Radiator Hose • Oil and Petrol Resisting Hoses Paint or Lacquer Spray Hose • Water Hoses

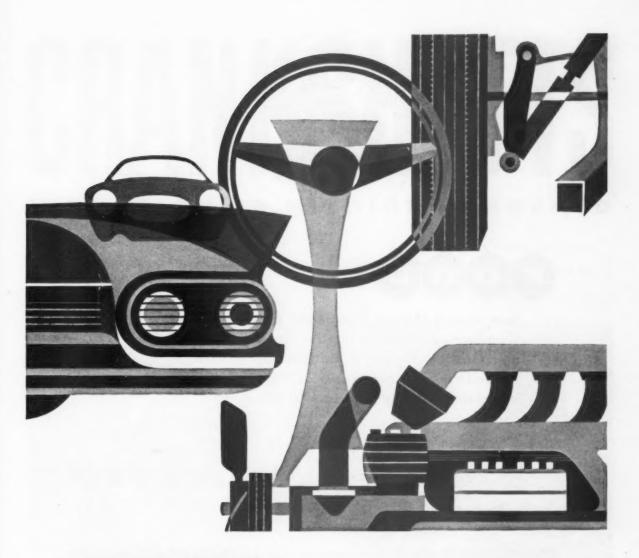
Dunlop technicians are available to advise on all matters concerning the installation and use of flexible pipes.

DUNLOP

DUNLOP MAKE FLEXIBLE HOSE BETTER TO LAST LONGER!

CONTACT DUNLOP RUBBER CO. LTD., ST. GEORGE'S ROAD, COVENTRY. TELEPHONE 64171 or EARLSWAY, TEAM VALLEY, GATESHEAD II. TELEPHONE LOW FELL 77877/8

CPH/9GH/



The future of design

E.M.I. Electronics Ltd. is now working in collaboration with leading motor manufacturers on an important new aid to design engineers — the application of analogue computer techniques to motor vehicle design.

Problems concerning dynamic behaviour, such as road holding, ride and stability of all types of vehicle, are all within the scope of EMIAC II—the most versatile analogue computer available today. EMIAC II enables studies of different vehicle design features (e.g. suspension, steering, mass distribution, etc.) to be undertaken rapidly and informatively, thus readily optimising the overall design. Studies are in progress embracing all aspects of vehicle design.

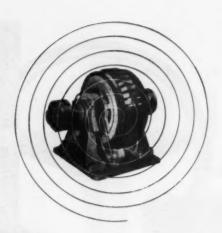
Originally evolved to solve the immensely complicated problems of guided weapon design, analogue computers have proved their worth in many other fields, and EMIAC II is daily solving problems for a number of leading aircraft and guided weapon companies, chemical plant engineers, and designers in numerous industries and research establishments.

Our book "Take Liberties with Time" fully describes EMIACII and its capabilities. Ask us for a copy now. Specific information is also available from our Analogue Computer Study Group.



E.M.I. ELECTRONICS LTD

CONTINUOUS PROCESS CONTROL DIVISION . HAYES . MIDDLESEX . TEL: SOUTHALL 2466



FORD too-

have chosen Heenan-Dynamatic Variable-Speed Couplings, for driving the Conveyors in their new Paint, Trim and Final Assembly building. These Drives are also in use at their Associate Company's Australian Plant.

HEBNAN-DYNAMATEC





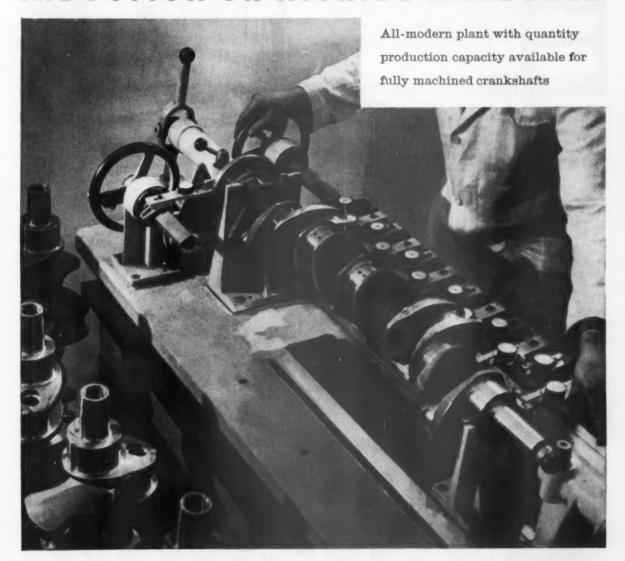
WE HAVE BEEN PRIVILEGED TO PROVIDE
HEENAN-DYNAMATIC CONTROLLED VARIABLE-SPEED
DRIVES TO THE MAJOR CAR MANUFACTURERS
INCLUDING B.M.C. (AUSTIN and MORRIS),
STANDARD, VAUXHALL, SIMCA, VOLVO, etc.

HEENAN & FROUDE LTD., ENGINEERS, WORCESTER, ENGLAND



CRANKSHAFTS

INDUCTION OR NITRIDE HARDENED



RRN

A member of the Guest, Keen & Nettlefolds Group of Companies

COMPANY LTD., PRECISION & GENERAL ENGINEERS

ALDRIDGE, STAFFS TELEPHONE: WALSALL 6561/9

AUTOMOBILE

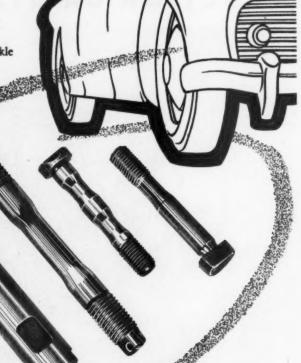
We are specialists in the manufacture of precision and standard fasteners for the Motor Industry

NEWALLOY - Wheel Bolts, Wheel Studs.

NEWALLASTIC -Cylinder Head Studs and Bolts, Connecting Rod Bolts, etc.

NEWALLEX - Induction hardened Spring Shackle Pins and Bolts.

Standard bolts and nuts supplied in "R", "T" and "V" quality, and other Alloy Steels.



Group of typical components, as supplied to the leading motor car manufacturers.

AND COMPANY LIMITED

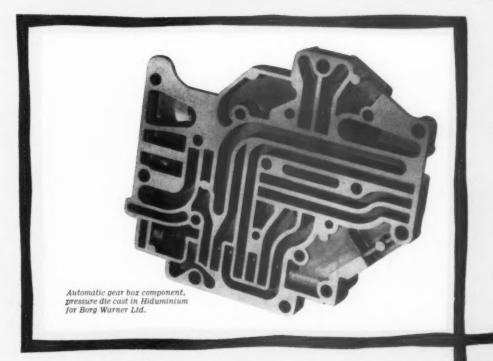
POSSILPARK

GLASGOW N. 2.

it can be done

Offset the rising spiral in production costs? It can be done.

Hiduminium is doing it. This casting is typical of a number of components of intricate design which used to be assembled from many parts—but which can now be made in one piece as an H.D.A. Pressure Die Casting. You can turn a dozen operations into one—with Hiduminium alloys and H.D.A. Techniques.



Hiduminium

makes the most of Aluminium

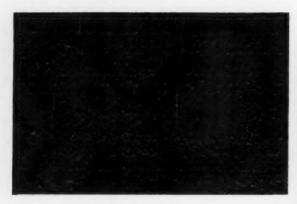
HIGH DUTY ALLOYS LTD., SLOUGH BUCKS.

Capasco takes care of the braking

non-fade moulded linings & facings

THE CAPE ASBESTOS COMPANY LTD

114 & 116 Park Street, London W.1 GROsvenor 6022













Transport Insulation with

Polyurethane rigid foams

made from I.C.I. ISOCYANATES AND POLYESTERS

Ask for details of Daltolacs 21, 22 & 24 and Suprasec D

Polyurethane foams provide excellent thermal insulation in all transport vehicles. They combine high thermal resistance with lightness, strength and low inflammability. Polyurethane foam components can be mixed on the site and poured or sprayed into position. The foams withstand vibration and adhere so firmly to adjacent surfaces that they actually strengthen the structure in which they are employed.

Patented in the main industrial countries



Enquiries should be addressed to:

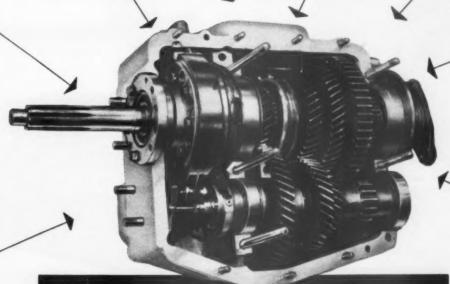
I.C.I. Sales Development Dept. (Polyisocyanates),

Ship Canal House, King Street, Manchester, 2.

IMPERIAL CHEMICAL INDUSTRIES LIMITED
LONDON SW1 ENGLAND

FEATURING

Moss Gear Box



NOW AVAILABLE FOR 6 OR 8 SPEED

Inclusive of Overdrive
Incorporating fingertip control
for double speed changing

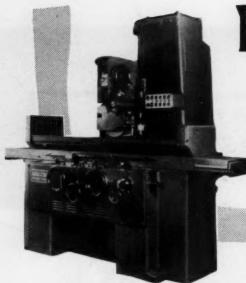
without declutching

MOSS

THE MOSS GEAR CO. LTD.
CROWN WORKS, TYBURN, BIRMINGHAM, 24

Telephone: ERDington 1661/6

Telegrams: 'Mosgear, Birmingham.'



MALCUS

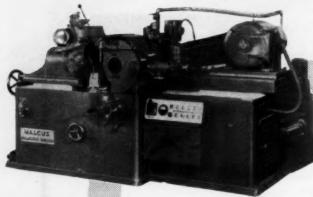
FULLY AUTOMATIC SURFACE GRINDERS

These MPR machines are manufactured in 3 sizes for 1,000, 1,500 and 2,000 mm table length, and our standard surface grinders, type MP, for 625, 750 and 1,000 mm table length.

STRAIGHTENING MACHINE

MALCUS Straightening Machine for bars of \$\frac{1}{8}"-\frac{5}{8}"\$ diameter and tubes up to \$1\frac{1}{4}"\$ diameter and of lengths up to 13 feet. This is a new type of straightening machine operating according to a patented method.





Selson

CENTRELESS GRINDERS

With MALCUS precision Centreless Grinders with plain bearings, Ward-Leonard coupling and micrometer adjustment, tolerances according to ISA 6 are easily obtained in continuous running. The machines are manufactured in 4 sizes and different kinds of feeding attachments.

The Selson Machine Tool Co. Ltd

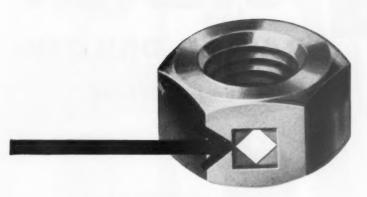
SUNBEAM ROAD, LONDON, N.W.10.
Telephone Elgar 4000

STANNINGLEY, Near LEEDS

Telephone Pudsey 2241

And at Kingsbury (Nr. Tamworth). Manchester. Glasgow. Swansea. Newcastle-on-Tyne Sheffield. Southampton. Belfast. Bath.





These fastenings are self-locking

The small, tough, resilient nylon pellet in a Wedglok fastening LOCKS it permanently against shock and vibration. Wedglok stays put in any position: seating is unnecessary. The moment driving or wrenching stops, Wedglok laughs at vibration, reversal of stress, temperatures between -70° and $+250^{\circ}$ F, moisture, solvents, age. It eliminates the need for lock washers, cotter pins or other auxiliary locking devices, simplifies design, and cuts assembly time.



include WEDGLOK Hexagon Socket

Screws and WEDGLOK Nuts in a
very wide variety of sizes. Other bolts
and screws can be made to order.

GKN WEDGLOK

GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD.,

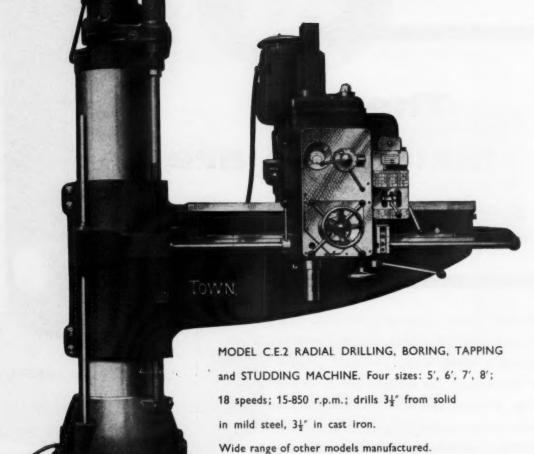
Screw Division: Box 24, Heath Street, Birmingham 18. Telephone: Smethwick 1441. Telex 33-239

S/WK/3026

TOWN

G.E.2.

RADIAL DRILLING
MACHINE



FRED" TOWN & SONS LTD

Makers of high class Drilling Machines for 55 years.

HALIFAX . YORKS

PHONE: HALIFAX 603

T.20

Automobile Engineer, November 1959



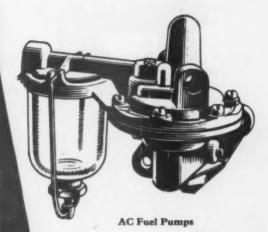




AC Thermostats







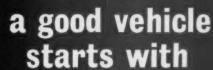


DELCO-REMY Oil-Filled Coils

Virtually every British vehicle has one or more AC-Delco products designed into it at drawing board stage. AC-Delco research engineers will gladly help when you are planning a new design or modifying an existing one.

These are a few in the wide range of AC-DELCO automobile and electrical products.

> AC - Delco - Delco-Remy are registered trade marks







DELCO-REMY Ignition Distributors

AC-Delco QUALITY PRODUCTS







Switches



AC Instruments







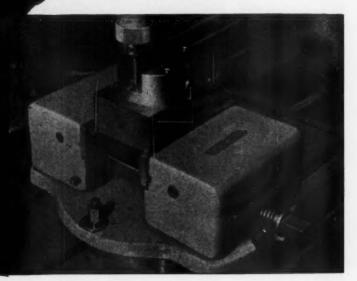
DELCO-REMY Electric Horns

EVEN ON A

THE PROPERTY OF THE PROPERTY O

Here is a Machine Vice with built-in precision. As its name implies, it actually grips the work hard down onto its table or parallels. An accurate set-up in seconds!

The illustrations show the boring of a location pin hole in a fuel pump assembly fixture at the premises of Messrs. AC-Delco, Liverpool, by whose courtesy the photographs are reproduced.



* BUILT 45 A MACHINE TOOL - FOR EFFORTLESS PRECISION

THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED ENGLAND

DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

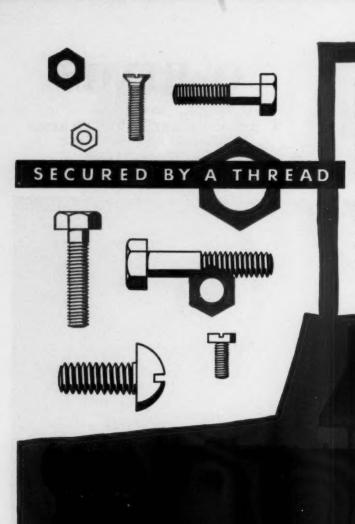
'O' RINGS

also

'U' RINGS · SQUARE-SECTIONED RINGS MOULDINGS AND BONDINGS Natural, synthetic and silicone rubbers



DOWTY SEALS LIMITED . ASHCHURCH . GLOS.



Whether it be a Whit., BSF, UNF, UNC, or B.A. thread it is all the same to C. Lindley & Co. Ltd., Luddenden, Yorkshire. They make all types of standard high tensile bolts and nuts from 4 B.A. to \$" diameter and are well known for the manufacture of special parts by the cold heading method. Their heat treatment, which involves hardening, tempering and normalising, is entirely carried out in four Birlec atmosphere controlled furnaces including 18" and 24" Birlec shaker hearths, and Birlec cast link conveyors. The weekly output of these Birlec furnaces is about 30 tons, operating 50 hours per week.

Birlec 18" shaker hearth furnace, rated at 40 kW, for hardening high tensile bolts and nuts at C. Lindley & Co. Ltd., near Halifax.

EXTRA-SPECIFICATION FURNACES*



BIRLEC LIMITED An A.E.I. Company

ERDINGTON · BIRMINGHAM 24 · Tel. EASt 1544

LONDON . SHEFFIELD . GLASGOW

NEWCASTLE-ON-TYNE . JOHANNESBURG

SM/B 5037

* The cost of a furnace is not necessarily its purchase price. Even a brief interruption in production may cause severe losses in output and serious inconvenience. The purchaser of a Birlec furnace can be confident that the equipment will not only meet his specification, but will give uninterrupted trouble-free service.

TRANSMISSION NOISE

How Metalastik tackle and solve the problems

Many transmission systems which, from their design and workmanship, could be expected to be reasonably quiet, do in fact turn out to be unexpectedly noisy.

We have analysed and diagnosed a number of such cases, and find that as a rule resonant torsional vibration is the culprit, a conclusion which agrees with the practical observation by some engineers that a normally noisy transmission becomes markedly quieter when driven through a fluid flywheel.

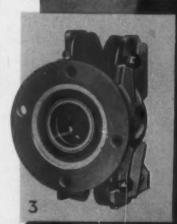
In most cases, one or another form of the Metalastik torsional vibration damper makes a striking improvement. Two forms, shown at 1 and 2, are used when analysis has shown the trouble to be due to resonant torsional vibration or cyclic fluctuation of the flywheel. They can be fitted in either of the positions shown, either behind the gearbox or in front of the final drive. When the amplitudes are unusually large the Metalastik unit No. 3 is used.

This is not an inertia-type damper but a flexible coupling, in which low torques—at which most of the flutter occurs—are transmitted with considerable flexibility by a bush in torsion, the buffers taking up the drive only at high torque. This coupling is fitted between engine and gearbox.

Our engineers are always available to investigate problems and to bring to bear their unsurpassed experience.

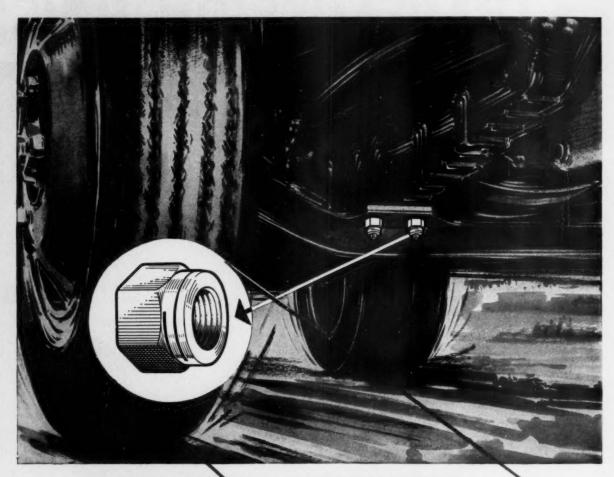






METALASTIK

ROAD TEST FOR A NUT-BUT...



A NUT WITH A DIFFERENCE!

The terrific vibration to which nurs are subjected on motor vehicles or cars leaves Philidas Sel Nocking nuts completely unmoved. Their fantastic tenacity is due to an ingenious opposing torque cross-cuts feature which sets up a tension that only a spanner can rehase. Heat change, vibration, oil infiltration, constant use. Inothing can make Philidas nuts loosen their grip.

The range of Philidas Self-locking nuts for all industrial parposes includes: Standard and thin industrial and turret nuts, Capped nuts, Single and double anchor nuts



SELF LOCKING NUTS



They yield only to a spanner
Send for new catalogue
PHILIDAS DIVISION — WHITEHOUSE INDUSTRIES LIMITED



Ferrybridge, Knottingley, Yorks. Tel: Knottingley 2323 (5 lines). Telex: 55166. Lendon Office: 44 Hertford Street, W.I. Tel: LEGation 3883. Telex: 23549

The comprehensiveness of the range of fine machine tools by British, Continental and American makers sold by Charles Churchill enables a manufacturer planning production to cover his entire requirement from this one source, ensuring co-ordinated deliveries and the soundest technical advice. When production planning call in Charles Churchill and Company Limited.



PRODUCTION PLANNING WITH CHURCHILL



CHARLES CHURCHILL AND COMPANY LIMITED,
COVENTRY ROAD, SOUTH YARDLEY, BIRMINGHAM 25.

Precision BORING, FACING AND UNDERCUTTING with the "closed circuit" hydraulic system



SEND TODAY FOR ILLUSTRATED BROCHURE

SWINDON TOOL COMPANY LIMITED INDUSTRIAL ESTATE, CHENEY MANOR, SWINDON, WILTSHIRE, ENGLAND

FROM THE TRADE

AGENCIES THROUGHOUT THE WORLD AUSTRALIA: Evans, Deakin & Co. Ltd., Charlotte Street, Brisbane. NEW ZEALAND: George E. Stock (N.Z.) Ltd., C.M.L. Buildings, Wellington C.I. UNION OF SOUTH AFRICA: Koppel Engineering Co. Ltd., P.O. Box 5682, Johannesburg. FINLAND: Firma Pivotex, Annankatu, 6B. Helsinki. SWITZERLAND: B. Schinz & Co., Beckenhof Street 6, Zurich 35.

MIDCYL RESEARCH

helps smooth out problems

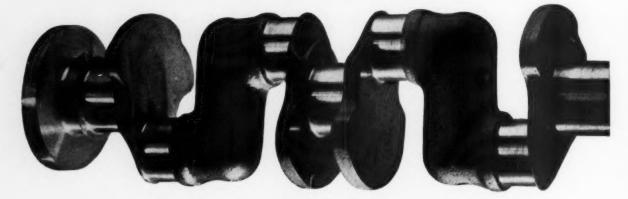


it is the continued research of Midcyl that helps smooth the way of the Auto Engineer with such of his problems as are associated with Cylinder Blocks, Cylinder Heads, Camshafts and Brake Drums



THE MIDLAND MOTOR CYLINDER CO. LTD., SMETHWICK, STAFFS

A new approach to



cast crankshafts in



Darcast announce the installation of plant for the quantity production of precision cast crankshafts.

quantity From tens to thousands per week.

precision Machining allowances down to as little as 0.030"

on journals and crankpins.

material S.G. (nodular) iron; min. tensile 35 tons p.s.i. Elongation 2-4%.

service Prototype to production, from one of Europe's most highly mechanised foundries.

Dartmouth Auto Castings Ltd
Dartmouth Road, Smethwick 40, Staffs



AUTOMOBILE ENGINEER

CONTENTS



LATEST OF THE ZF RANGE OF HYDROMEDIA GEARBOXES, AS EXHIBITED AT THE FRANKFURT SHOW, THE COMMERCIAL VEHICLE SECTION OF WHICH IS REVIEWED IN THIS ISSUE

- 405 Editorial Disc Brake Standardization
- 406 German Commercial Vehicles A review of some of the most interesting recent developments
- 420 Jaguar Innovations 3.8-litre engine available on unitary model; front suspension modifications, wider rear track and larger glass area
- 421 Harperizing Buffing process for finishing components of intricate shape
- 422 New Perkins Engines Description of two four-cylinder industrial units, of 3.33 litres and 3.15 litres swept volume, embodying a number of interesting features
- 424 Engine Performance Improvement Latest developments in water and water alcohol injection K. Weiss and J. W. Rudd
- 433 Modified Humber Cars Super Snipe with larger bore engine, suspension modifications and disc brakes: minor changes to Hawk model
- 435 Albion Cab Sub-Frames Standard structures available in two forms for four commercial vehicle models
- 436 Corvair Engine Die Castings British process for producing aluminium low-pressure die castings used for the Chevrolet compact car
- 438 The Ford Paint Shop Occupies the whole of the first floor of the new paint, trim, and assembly building, and is equipped with duplicate systems handling body shells for all models
- 446 Aluminium Coating An anti-corrosive treatment with decorative possibilities

Published the second Wednesday in every month by 1LIFFE & SONS LIMITED Dorset House, Stamford Street, London, S.E.1 Telephone: Waterloo 3333 (60 lines) Telegrams: Silderule, Sedist London The annual subscription inland and overseas is £3 0s 0d including the special number Canada and U.S.A. 88.50

C ILIPPE & SONS LIMITED, 1969

BRANCH OFFICES
Coventry · 8-10 Corporation Street
Telephone · Coventry 25210
Birmingham · King Edward House, New Street, 2
Telephone · Midland 7191
Manchester · 260 Deansgate, 3
Telephone · Blackfriars 4412 and Deansgate 3595
Glasgow · 26B Renfield Street, C2
Telephone · Central 1265

Which helmet?

Heavy and strong to resist deep-sea pressures, or light and shock-absorbent to wear all day in a coal-mine?

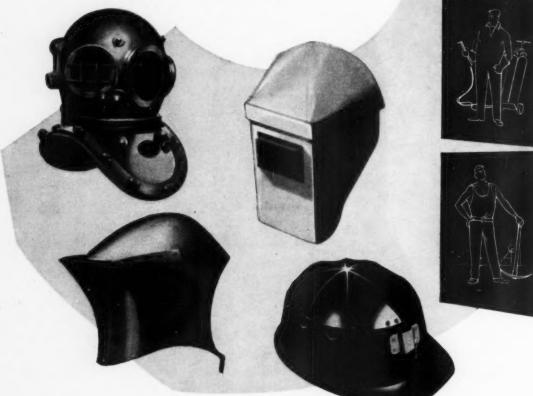
Each helmet has its correct place and so has a bearing. A life can depend on a helmet and a machine can depend on a bearing. The care, attention and precision which goes into the making of every BESF ball or roller bearing coupled with the unrivalled technical experience of their application to every kind of work in all parts of the world, means that BESF can offer the right bearing for the job it has to do.











THE SKEFKO BALL BEARING COMPANY LIMITED . LUTON

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER & SPHERICAL ROLLER

DESIGN MATERIALS AUTOMOBILE PRODUCTION METHODS WORKS EQUIPMENT

Disc Brake Standardization

NE of the most significant trends in Great Britain this year has been towards the adoption of disc brakes on new cars of 1½ litres and over. As has so often happened in the past, this type of brake was pioneered on racing vehicles, then it was fitted to high price cars, and now it is beginning to be employed on the medium-price models. In fact, over a third of this year's new British models is equipped with disc brakes, in most instances on the front wheels only.

Because of its basic robustness, freedom from fade, and rapid water recovery, the disc brake will undoubtedly continue to oust the drum type, except possibly on smaller cars of relatively low performance. Also, it can be expected to be applied increasingly to commercial vehicles. As the quantities manufactured become greater, so should the production costs diminish, provided rationalization is adopted so far as possible by the automobile industry. Clearly, the number of different components and assemblies must be kept to the practicable minimum if the full benefits of large-scale production, in respect of economy, are to be gained.

It will be readily appreciated that there are two viewpoints in respect of standardization. On the one side, the makers of brake equipment and lining materials would be delighted if they had to produce only two different sizes of pads, discs and caliper assemblies, with a similar degree of standardization in respect of materials. From the standpoint of the vehicle manufacturers, however, such Utopian simplification is out of question. Within the general classification of vehicles to which disc brakes could be applied, there are three categories of cars alone: these are high-performance sports cars, relatively heavy cars for which servo assistance is necessary, and lighter cars without such assistance. In each case, the basic problems differ and so, therefore, do their solutions in terms of the most satisfactory brake specification.

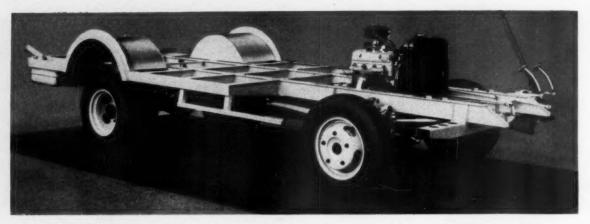
Again, considerable differences can exist between the requirements of broadly similar vehicles from the various factories. One of the most common variables is weight distribution. Since, for optimum retardation, the correct balance of braking effort between the front and rear wheels is essential, a range of piston sizes is necessary for any given caliper size.

Another difficulty is that two generally similar cars may have road wheels of different diameters, the smaller of which obviously provides less installation space for the brake discs. The necessarily reduced disc diameter must be compensated by the use of larger pistons, and even of heavier caliper units to ensure adequate resistance to the higher clamping forces. As an indication of the range needed, one brake manufacturer quotes a 2½:1 ratio of the highest to the lowest clamping loads currently employed for private cars. From practical considerations, it would therefore appear impossible to reduce the range of caliper units below three; more would be required for commercial

Different friction material characteristics are, of course, necessary for each of the three categories of cars mentioned earlier; and even within one category, two vehicles of apparently similar type could have different requirements, because the superior handling qualities of one could put heavier demands on its brakes. Also, the existence of certain patents has resulted in variations of pad shape as between one brake manufacturer and another. Because of this, no lining manufacturer attempting to cover the whole range could produce less than nine different pads, even assuming only one size was required in each shape and type of material.

Another factor that militates against standardization is a product of the current state of transition from drum to disc type brakes, and will, therefore, tend to become less troublesome in the future. When converting an existing drum type layout to disc braking, the vehicle manufacturer obviously desires the minimum of alteration to the surrounding components. Consequently, it may not be possible to use a disc brake already in production, even though it might otherwise be suitable.

Although there is clearly no easy road to standardization on disc brakes, the overall picture is decidedly more favourable in this respect than is that of the drum brake. The enormous variety of drum diameters and widths, and lining lengths and materials, can be largely attributed to the fact that this type of brake has grown up with the motor industry. On the other hand, the disc brake has come on the scene at a time when automobile technology has reached levels that were unforeseen at the beginning of the century. In another few years, when adequate field experience has been acquired of a wide variety of disc brake installations, it should be possible to lay down standards which, although they may not be ideal for all, will represent the best compromise between production economy and operating efficiency of all road vehicles.



The Borgward B611 chassis has independent front suspension and a torsionally stiff frame, with box section cross members, outriggers and side members

GERMAN COMMERCIAL VEHICLES

A Review of Some of the Most Interesting Recent Developments

WO years ago, because of confusion caused by restrictive legislation regarding dimensions and loadings of road vehicles in Germany, the heavy commercial vehicle section of the industry in that country was experiencing serious difficulties. Operators were not buying new vehicles because they felt that the regulations were bound to be changed, and they therefore had to know whether the vehicles they would buy and operate would meet the requirements of the regulations in their final form and, at the same time, be economical and competitive.

At that time, therefore, the manufacturers felt that they had to resort to extreme measures to attract customers. These measures included the exhibiting of their latest technical advances at a much earlier stage of development than they normally would have done. Since then, development has proceeded and the situation, so far as its technical aspects are concerned, has to a large extent stabilized, despite the fact that the legal position is still far from clear. Some of the restrictions now imposed by the German government will place the vehicles produced in that country at a disadvantage in competition on an international scale in Europe. For example, the gross weight of a two-axle truck is limited to 12 tonnes, and of a rigid six-wheeler to 18 tonnes.

Incidentally, one result of the uncertainty in the German home market has been a considerable drive in the export markets. The export figures for 1956, 1957 and 1958 are respectively 71,246, 82,033 and 102,877, which represent gains of 10,787 and 20,844 in 1957 and 1958. In other words, the increase in exports for 1958 was almost twice as high as that for 1957, relative to the year before in each case. The figures for the whole of 1959, of course, are not yet available.

Technical developments

Because of the all out effort made two years ago to impress potential customers with advance information on technical developments, there were few new features at the Frankfurt Show this year. However, with the general return to more stable conditions, the scene has become clearer and some interesting trends have become apparent. Among the new features is the Krupp two-stroke diesel engine with an

aluminium alloy cylinder block and crankcase and a separate injection pump to serve each injector. Another feature of considerable interest is the employment of a hydraulic drive for the radiator fan on the Mercedes-Benz 0 322 bus.

Independent front suspension is employed for three different makes of chassis designed for vehicles with a payload of approximately 2-tonnes, and there are signs that if this trend continues it may be accompanied by a revolution in frame design. M.A.N. and Krauss Maffei have joined forces and are producing passenger vehicle chassis with rearmounted horizontal underfloor engines. Büssing also have adopted this layout. In all instances, the engines are installed with their crankshaft axes parallel to the longitudinal axes of their vehicles, so that their drives can be taken straight forward, through a conventional clutch and gearbox, to the rear axle. One of the objects of the rear-engine arrangement is to obtain a good weight distribution between the front and rear axles, especially for one-man operated buses: in these vehicles there is a tendency for passengers to congregate at the front end, and the situation is aggravated by the relatively large front overhang permitted by local regulations.

The rear-mounted underfloor engine layout has a number of advantages, in addition to the favourable weight distribution and the straight transmission line already mentioned. Access for servicing can be better than when the engine is installed in the central position, since the layout can be such that the installation can be approached freely from three sides. However, the maximum benefit in this respect can only be obtained if auxiliary components such as the injection pump, starter-motor, dynamo and compressor are suitably disposed. With the engine mounted under the floor, there is, of course, no encroachment on the space available for passengers and, provided difficulties with regard to the rear platform arrangement can be overcome, it might be particularly suitable for double-deck vehicles.

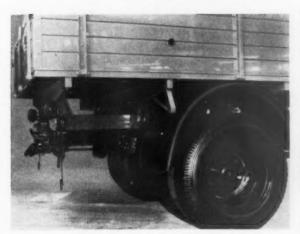
Enthusiasm for air suspension has waned, at least for the time being, although practically all the large manufacturers exhibited at least one chassis incorporating this feature. In almost all instances, two air springs of the double convolution bellows type are employed at the front and four at the back, but M.A.N. have adopted the rolling diaphragm type of

air spring, presumably because of the facility with which it can be arranged to give a variable rate. Operators of tankers and trailers are most interested in air suspension, the former especially because of the rigidity of the tank, and the heavy loads therefore applied to its mountings when the stiffer forms of suspension are employed; but both tanker and trailer operators are, of course, much concerned with the problem of providing a suspension that will cope with the great difference between the laden and unladen weights of their vehicles. In general, the principal objection to air suspension systems is the maintenance difficulties that may arise.

Borgward

One of the most interesting vehicles currently produced by Carl F. W. Borgward G.m.b.H., of Bremen, is the B611 model. The chassis has a wheelbase of 8 ft 6 in and its track dimensions are 5 ft 3 in front and 4 ft 11 in rear. A turning circle of only 35 ft 6 in is claimed. The unladen weight of the chassis, with cab, is quoted at 2,825 lb with the diesel engine installation, and 2,785 lb for that with the petrol engine. The maximum load on the front axle is 2,970 lb and 2,815 lb for the diesel and petrol engine versions respectively, and that on the rear axle is 4,840 lb for both. A maximum all-up weight of about 7,700 lb is specified, with a payload of approximately 4,000 lb: these figures vary slightly, of course, with the type of body employed.

Noteworthy features of this vehicle are its independent front suspension and the frame construction. The suspension and steering assembly is mounted on a box section cross



member, which is secured beneath the side members of the frame by one bolt passed vertically through the frame member on each side; a relatively thin sheet of rubber is interposed between the seating faces of the members. By itself this method of attachment would only be adequate for taking the vertical forces, and an additional component is, of course, needed on each side to take the drag and brake torque reaction. This component is a tubular strut passed through holes in the front and rear walls of the box section cross member, and welded into them. The trailing end of each strut carries a rubber bushed eye, and is attached to a bracket on the frame side member.

There are a number of advantages with this arrangement. One is that the frame side members and the cross member that carries the suspension and steering assembly are of the simplest possible form: almost any other means of integrating them would involve the use of complex pressings and gussets, and would entail stress concentrations. Removal of the suspension and steering assembly for servicing is very easy, and the whole structure is light and economical to manufacture.

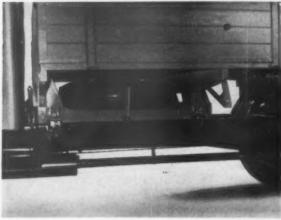
A three-piece track-rod steering layout has been adopted and, as can be seen from the accompanying illustration, a damper is connected between the arm on the upper end of the idler assembly and the frame side member. A conventional stub axle and knuckle type swivel arrangement has been adopted, and both the upper and lower transverse wishbone links are steel forgings, with screw type outer bearings and rubber bushed inner ones. Telescopic hydraulic dampers are housed coaxially within the coil springs.

The frame is unusual for this type of commercial vehicle, in that it obviously has considerable torsional stiffness. This is a feature that is particularly desirable when independent front suspension is employed, as was discovered many years ago by the car manufacturers. It is desirable because the torsional loading on the frame is considerably greater than with conventional semi-elliptic springs, which have to be relatively close together to clear the wheels on full lock.

A ladder type frame layout has been adopted, but all its main cross members are of box section and are behind the engine. In fact, apart from the suspension cross member, which, as has already been stated, is a bolted on component, there are three between the engine and the rear axle, and one behind the axle. The other two cross members are of

Left: Installation of the horizontal engine under the floor at the rear of the M.A.N.-Krauss Maffei bus, which is suitable for one man operation

Below: The bcdies of the Magirus-Deutz trucks are each mounted on two sub-frames, one at the front and one at the rear, to avoid load concentrations on the frame side members of the chassis while at the same time retaining a satisfactory degree of torsional flexibility

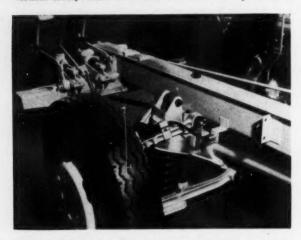


Automobile Engineer, November 1959



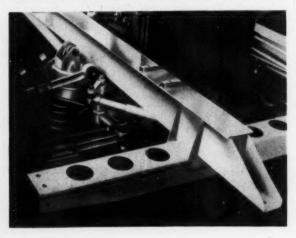
This is the bus on the Borgward B611 chassis illustrated on the first page of this article. Another body that can be supplied is the Express van, like the bus in appearance but without the side windows; the chassis is also available with a cab and with either a removal van, box van or livestock transporter body, or as the Express truck shown on the opposite page

light construction, and are of channel section. There is one at the extreme front end, and the interesting feature of this is its rigid gussetting to the side members. The arrangement of the gussets can be seen in the accompanying illustration. Lightening holes are punched in the relatively lightly loaded horizontal portion of this channel section, but not in the vertical faces, which of course are more heavily stressed.



Above: Independent front suspension of the Borgward B611, showing the simplicity of form and attachment of the suspension cross member

Below: On the Borgward chassis, a steering damper is employed and the front cross member is gussetted by U-plates to the side members



The second channel section cross member is at the extreme rear, the ends of the side members fitting between the arms of the channel. This cross member is swept round the sides, and is welded to a box section member that is swept up to stiffen the outer edge of the wheel arch. From the front end of this box section member, another channel extends forwards, and its arms embrace the ends of outrigger extensions of the three cross members between the front and rear axles. The outriggers, like the side members, are of box section formed by inverted top-hat sections with closingplates welded on to their flanges. Sheet steel, 2 mm thick, is employed for these sections, and the dimensions of the side members are 4½ in deep × 3¾ in wide. The central portions of the box section cross members are each formed by two shallow channel sections placed back to back, with the appropriate space between them and with closing-plates welded, on top and below, to their flanges.

Where the chassis is intended for an open type, goods carrying body, instead of a van or bus, there are only four outrigger brackets and they are no more than about $5\frac{1}{2}$ in long, to carry the rear spring hanger brackets, that is, there are no outriggers on the two central cross members. The truck body is mounted on longitudinal timber beams extending along the top of each side member. In general, the frame layout as a whole is interesting because of the rigidity of the portion behind the engine and gearbox and the relative freedom of the two cantilever extensions of the side members on each side of the engine. One might expect some form of gussetting to be necessary between these forward extensions of the side members and the cross member immediately behind the engine installation, since this obviously is a point of stress concentration.

Among the other noteworthy features is an air intake tube with holes drilled in it along its length, for tuning to reduce noise. This tube extends forwards from the air filter, in the usual manner. Some of the ball joints on the linkage between the steering column gear shift control and the gearbox are of necessity installed with the open sides of their cup components facing downwards. This would make lubrication by normal means difficult, but a collar, about 1 in diameter × approximately $\frac{1}{8}$ in thick, made of synthetic sponge rubber, is fitted round the neck of the ball component. Lubricating oil applied to this collar is soaked up by the sponge and subsequently spreads into the ball joint.

The cab layout is worthy of study. It is of the forward control type, with three seats. The central seat is mounted on top of the engine cover, and the floor is completely free of obstruction over the whole of its width. Access to the engine is gained by undoing two large rubber clips and pivoting the cover about the hinge at its rear edge. The seat for the driver can be adjusted for height and longitudinally.

A good instrument layout has been adopted, the instruments being mounted on a rectangular panel that can be easily removed for servicing. There is another noteworthy feature in the heater system: the outlet on each side of the toe-board has a curved deflector plate fitted to it to direct some of the warm air on to the legs of the occupants. Without this deflector, the tendency would be for the air to flow out to the sides of the vehicle. Good distribution of warm air undoubtedly is essential because both the engine and the radiator are behind the heel-boards.

Büssing

Among the vehicle chassis that have been exhibited by Büssing Nutzkraftwagen G.m.b.H., of Braunschweig, is the 11 RU 7H model, which has an underfloor engine installed at the rear. This engine develops 145 b.h.p. at 2,500 r.p.m. Its maximum torque output is 333 lb-ft at 1,400 r.p.m. The swept volume of the unit is 7,150 cm³.

The vehicle is available with the ZF Hydromedia gearbox or an ordinary synchromesh, layshaft type box. It has a generator beneath it, both being belt driven. The starter is mounted above the sump and drives a ring gear on the flywheel in the conventional manner. A long belt-drive is taken to the radiator fan which, together with the radiator, is installed on the right-hand side of the chassis. This fan drive is in two stages, the intermediate pulley being on a spring-loaded telescopic tensioner strut. The fan is of the ducted type, with a rubber connection between the duct and the radiator shroud. Cambered guide vanes are fitted at the entrance to the fan duct. All the Büssing vehicles are noteworthy for the efficiency of their radiator and fan installations.

The frame is of riveted construction, with channel section



Borgward Express truck. When this body is fitted to the B611 chassis, two of the intermediate outriggers behind the engine are omitted and the remainder are short

wheelbase of 4,600 mm (approximately 15 ft 1½ in) and its overall length is 10,000 mm (32 ft 9½ in). Normally the unladen weight is 12,000 kg (approximately 24,400 lb)

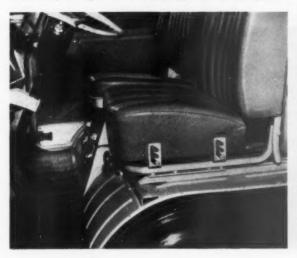
but under peak traffic conditions this permissible weight is increased to 13,200 kg (29,000 lb), when the complement of people carried is 100. This loading is accomplished, of course, with a high proportion of standing passengers.

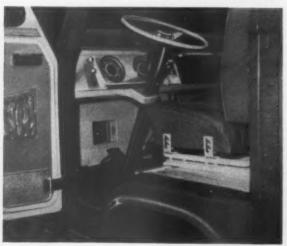
With this engine installation, the cylinders are horizontally disposed towards the left-hand side of the vehicle, where their heads and injectors are readily accessible for servicing. The injection pump is mounted on the rear of the block, and also is accessible from the back of the vehicle. On the rear end of the sump is mounted the compressor, with the

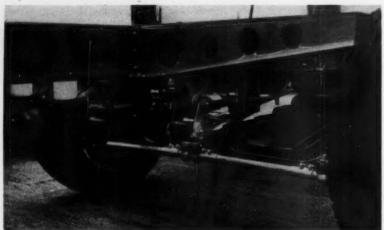
side members extending straight from front to rear. Practically all the cross members are of top-hat section with fairly closely pitched lightening holes along their tops and sides. Strap plates, over the top and bottom of each side frame, connect the cross members to the side frame and to their outrigger bearers.

Perhaps one of the most interesting features of this vehicle is its suspension. At the front, the unladen weight is carried by semi-elliptic springs, but they are used in conjunction with air springs to accommodate variations in load.

Two views of the Borgward B611 cab, showing the clear floor, engine cover with a seat above it, and the simple method of seat adjustment for height







On the Büssing 11 RU 7H, semi-elliptic springs are used in conjunction with air springs at the front. The leaf springs carry the unladen weight of the vehicle, while the air springs compensate for variations in the passenger load at that end

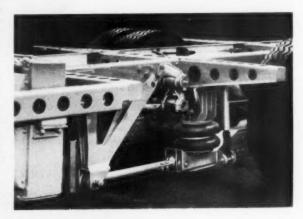
This is a particularly useful combination for one-man operated vehicles, in which passengers tend to congregate at the front end, where an automatic ticket machine may be installed. As has already been mentioned, it is to offset this adverse condition of load distribution that the rear engine layout has been adopted.

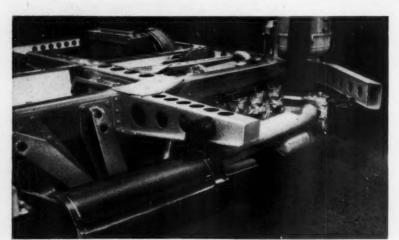
The air springs are mounted outboard of the leaf springs, directly above the axle. This is a good arrangement in that the leaf spring, of course, has to be sufficiently far away from the wheel to clear it in the full lock position. The air springs are of the double convolution bellows type, and each has a large cylindrical auxiliary reservoir immediately above it, as can be seen in the illustration on the right. Two channel section cross members are riveted between the frame side members, to support the air spring mounting bracket, which is bolted to the outer face of each side member. There is a Knorr Bremse levelling valve on each side.

At the rear of the vehicle, the semi-elliptic spring, mounted above each end of the axle, comprises only three leaves, the centre one of which is extended to form the eye at each end. Evidently, the main function of this spring is lateral location of the axle, since both its ends are connected to a shackle. Brake torque is reacted by two air springs disposed one at each end of a longitudinal beam clamped under the axle, below the leaf spring. Longitudinal location of the axle is effected by a rubber bushed link on each side. This link extends rearwards from the trailing end of the beam that carries the air springs, and is attached to a bracket extending downwards from the side member. A long telescopic shock

The long cylindrical auxiliary reservoirs above the air springs at the front of the Büssing 11 RU 7H model are accommodated inside the wheel arch pressings



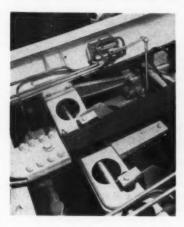


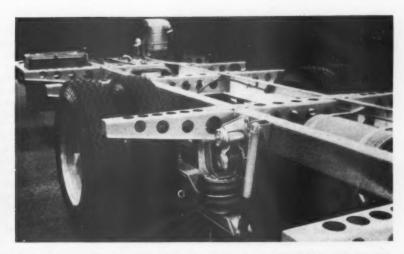


Rear suspension of the 11 RU 7H, showing an air spring, and a leading link and light leaf spring for the location of the axle

Left: The underfloor engine installation at the rear end of the Büssing 11 RU 7H vehicle

Below: Details of the centrally mounted leaf spring that locates the rear axle on the Büssing 13 RU 10. Another interesting feature is the three-point silencer mounting





Above: Rows of tubular ties are welded in transverse holes in the hollow longitudinal beams that carry the air springs and form the auxiliary reservoirs on the Büssing 11 RU 7H vehicle

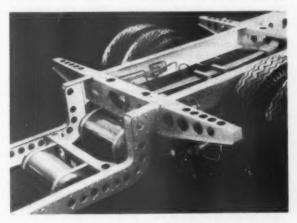
absorber is connected to each end of the longitudinal beam. An interesting feature of the suspension installation is that the beam is hollow and forms the auxiliary air reservoir for the springs. To prevent the beam from ballooning under the air pressure, tubular rivets are inserted transversely through it and welded in their holes in its side plates; as can be seen from the accompanying illustration, there are two rows of rivets on each beam. Where the bolts pass through the beam to secure it to the axle, a sealing compound is applied to the seating faces. Only one height regulator valve is employed, and it is on one of the cross members.

Another interesting vehicle is the Büssing 13 RU 10 model. So far as overall layout is concerned, it is conventional, with an underfloor engine between the axles. However, at the front it has a conventional leaf spring suspension, with a hollow rubber assister spring arranged above the retainer plate of each of the semi-elliptic springs, as shown in the accompanying illustration, while at the rear it has a new form of air suspension installation.

In general, the construction of the frame is similar to that of the model previously described. A noteworthy detail, which is used on most of the Büssing chassis, is the flexible mounting arrangement for the exhaust system. A typical mounting fixture can be seen in one of the illustrations of the suspension arrangement. It comprises simply a tie-rod suspended from a circular rubber mounting of large

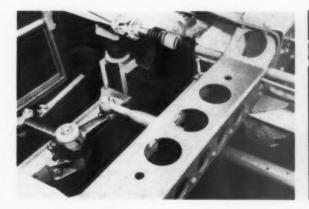
dimensions. Although the rubber is in tension, this probably does not matter much, since it presumably is relatively lightly stressed. On this particular vehicle, a three-point mounting is used for the very large diameter silencer mounted transversely beneath the anti-roll bar. All three of these mountings are of cylindrical form: two, which take the main weight of the unit are in compression, while the third, which acts simply as a steady attachment, is in tension.

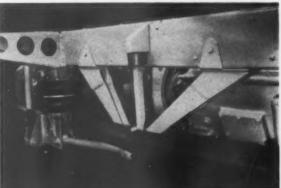
As in the model previously described, four double



Right: Rear suspension and the rubber mounting for the 13 RU 10 exhaust

The two illustrations below show details of the 13 RU 10 chassis: on the left is the front suspension and on the right is part of the rear suspension





Automobile Engineer, November 1959



For some time, Tempo have been manufacturing this six-seater cab with a pick-up body. The engine is between the front and rear seats

convolution bellows type air springs are employed for the rear suspension, and they are mounted on the ends of two longitudinal beams, one on each side, which also serve as the auxiliary reservoirs. The single automatic levelling valve is accommodated on one of the frame side members. A substantial torsion bar stabiliser is installed, and the ends of its arms are connected by shackles to the axle. The axle location of this model differs from the other in that trailing links instead of leading ones are employed, that is, they are connected to the front ends of the beams on which the air springs are mounted. In this installation, the axle pads, on which the longitudinal beams seat, overhang so that the bolts that clamp the beams to them do not have to pass through the beams, and therefore sealing problems do not arise. The novel feature of the arrangement is the employment of a single leaf spring, centrally mounted on top of the differential casing, for lateral location. This spring comprises only two leaves, and on each end of it is clamped a fitting connected to a shackle carried in a bracket attached to a frame cross member.

The merits of this arrangement are as follows: the unsprung weight is much less than it would be if two leaf springs were employed, one on each side; the cost is reduced, not only by virtue of the fact that only one light spring is used, but also because of the consequent reduction in the number of end attachments; the number of points requiring maintenance attention is also reduced; and a more compact suspension installation arrangement can be adopted, since it is not necessary to accommodate leaf springs as well as the axle beams beneath the frame side members.

Ford

Among the models that are produced at Ford-Werke AG, of Köln, are a number of different versions of the FK 1250. They include a variety of vans, trucks, pick-ups, mini-buses and ambulances. The chassis is not new and some details

of it were given in the February 1958 issue of Automobile Engineer. However, the latest version is a pick-up with an extra large cab for the carriage of a working party and their equipment. In fact, the cab will probably accommodate about six people.

As with the other versions of this model, the engine installation is between the two front seats. The wheelbase is 2,300 mm (approximately 7 ft $6\frac{1}{2}$ in), and the track dimensions are 1,340 mm (about 4 ft $4\frac{5}{4}$ in) front and 1,360 mm (approximately 4 ft $5\frac{5}{8}$ in) rear. This vehicle is designed for an all-up weight of 2,400 kg (5,280 lb).

Integral construction is employed for the vehicle structure. The floor level is at the top of the wheel arches, so that the load carrying platform is completely unobstructed. It has drop sides and there is a gate at the rear end. The under frame, which is integrated with the cab structure, comprises deep beams formed by single webs flanged along their upper and lower edges. There are two main longitudinal beams between the wheel arches, and the panelling below the drop sides forms two more longitudinal beams. Cross members are formed by the rear wall of the cab and the rear end panelling of the body, and there are three more intermediate cross members. The large corner panels at the rear ends of the vehicle form rigid pillars on each side of the door, and they sweep round the flanks to support the catches for the drop sides. There is a marked trend towards the adoption of integral construction for the light commercial vehicles, because of the weight saving that can be achieved by its use.

Hanomag and Tempo

Vidal und Sohn Tempo-Werk G.m.b.H., of Hamburg-Harburg, also produce a vehicle similar to the Ford model already described. There are three versions of this vehicle, one on the Wiking, another on the Rapid, and the third on



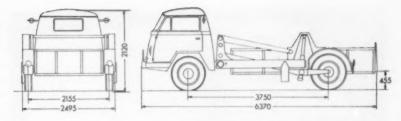


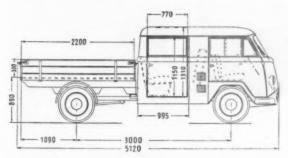
Noteworthy features of the Ford six-seater cab and pick-up, shown above, are its integral construction and forward control layout, with the engine well back between the two front seats

On the Wumag, the hydraulic controls for raising and lowering the body, and the mechanical control for the cotch that locks it in the intermediate position, are one above the other at the front end of the side frame

Right: These two views give the overall dimensions of the Wumag vehicle, which is designed for on- or off-loading from any height between ground level and 1,555 mm

Below: The principal dimensions of the Tempo six-seater cab and pick-up, which is also shown at the top of the opposite page. As in the illustration on the right, all these dimensions are in millimetres





the Matador chassis. The first two have cabs capable of accommodating five persons, while the third will carry six persons. Their load carrying capacities are 470 kg (1,035 lb), 450 kg (990 lb) and 875 kg (1,925 lb), for the high loader versions; the capacities of the low loaders are the same except that of the Wiking, which is 10 kg (22·2 lb) less.

The layout of the vehicle can be seen from the accompanying illustrations. The chassis is arranged, as before, with the engine, petrol tank and spare wheel accommodated behind the front seats. It comprises the well known tubular backbone frame with independent front and rear suspension. A 452 cm³, two-cylinder, two-stroke Heinkel engine, developing 20 b.h.p. at 4,000 r.p.m., is used to power the Wiking chassis; the Rapid has a 950 cm³ Austin engine, which develops 32 b.h.p. at 4,100 r.p.m.; in the Matador, a 1,489 cm³ Austin power unit is employed, and it develops 48 b.h.p. at 4,100 r.p.m. The platform on the high loader is 890 mm (approximately 2 ft 11 in) above ground level, while this dimension on the low loader is 640 mm (approximately 2 ft 11 in).

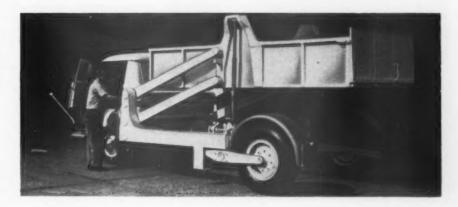
New additions to the Tempo range are the 3-tonne and the 1½-tonne Wumag models. These are vehicles with a chassis which, as viewed in plan, is of approximately Y-shape, the cab being over the leg of the Y and the body between the two arms. The useful feature of this arrangement is that the body can be lowered, hydraulically, to ground level or raised to any height up to 1,555 mm (approximately 5 ft 1 in) for loading and unloading. This is particularly useful for

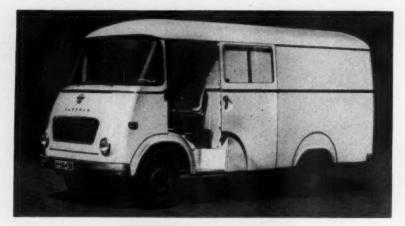
vehicles used by railways, for loading or unloading at ramps or railway trucks. Another application for this type of vehicle is for the transport, in factories, of goods such as are contained in drums, barrels and gas cylinders.

In general principle, this layout has been used for lighter vehicles for many years by this firm, but previously the side members, which carry the rear suspension, have each comprised a tubular framework, as illustrated in the February 1954 issue of Automobile Engineer. In the latest version, shown in an accompanying illustration, a much more robust form of construction is employed. The arms of the Y are single cantilever tubes of rectangular section which, on the larger version, are 7 in × 9 in deep. These carry a trailing link type suspension at their rear ends, and their front ends are welded to a transverse tube 71 in diameter. Near the centre of this transverse tube, two more longitudinally arranged tubes, about 5 in diameter, extend forward to form the leg of the Y and carry the cab, engine and front suspension. These two tubes are passed through diametrical holes in the cross member and welded in. The upper pivots of the double transverse link front suspension system are carried on brackets on the top of the tubes, while the lower links are pivoted on pendant brackets, the lower ends of which are tied together by transverse stay tubes of small

Behind the cab, two parallel arms on each side extend rearwards, to carry the body. Their trailing ends are pivoted slightly forward of the mid section of the body, where the two-stage hydraulic jack is attached. The front ends of the arms are joined by transverse tubes and pivoted on two vertical posts, one on each side, just behind the cab; between the pivots, another tubular cross member braces the two vertical posts, the lower ends of which are welded to the side members. Secured to each side of the body, between the pivots of the trailing ends of the parallel arms of the body-carrying mechanism, is a large stop which, when the body is in its normal position, rests on a hook pivot-mounted on the side frame. To raise the body, the hydraulic control, mounted on the front face of one of the vertical posts, is operated to extend the jacks. On the other hand, before the body can be lowered from its normal position, it must first be raised slightly so that the hook on each side can be

A two-stage hydraulic jack is employed on each side to raise or lower the body of the Wumag, for loading or unloading the vehicle at ground level or at a ramp or railway wagon





On the Hanomag Kurier van, the sliding door moves outside the vehicle to avoid encroachment on the space in the interior



Right: The neat instrument panel arrangement, with push button electric switches, on the Kurier van, details of which are shown in the other illustrations above and below, on this page



Curved ends of guide channels for rollers at the front corners of the sliding door of the Kurier van pull the leading edge of the door tightly in against the pillar



Catch and swinging arm mechanism that pulls the rear edge of the sliding door in against the pillar. A rubber pad is interposed between it and the door inner panel



Access to the rear compartment of the Kurier van is extremely good when the passenger's seat at the front is tilted forward disengaged by means of a mechanical linkage and a lever immediately below the hydraulic control, and then the hydraulic control can be operated to lower it.

The suspension on each side is a double rocking beam. Between its trailing arms is carried the wheel, and its front end bears on the coil spring, which is carried in a U-shape bracket below the side member. There is no hydraulic damper. Since the rear end of this vehicle is appreciably wider than the cab, two large arms are installed, one on each side on the front bumper, to indicate to the driver the width of the portion that is out of sight behind the cab.

One of the latest additions to the range of vehicles produced by Rheinstahl Hanomag AG is the Kurier van with sliding doors at the front. The mechanism of the doors is arranged so that when they are slid back they pass along outside the van, and therefore do not restrict the space available in the interior. At the top of each sliding door, the front and rear corners are fitted with brackets that carry rollers running in a guide channel; similarly, the corners at the lower edge of the door are also guided. However, only three of these rollers are vertical and carry the weight of the door: the fourth, which is that at the front upper corner, is horizontal and runs in a channel, the forward end of which curves inwards to guide the front edge of the door inwards to seat against the shut pillar. A similarly horizontally positioned roller on the extreme front edge of the door enters a short channel, also turned inwards, immediately above the wheel arch. These two attachment points are shown in the illustration above.

The mechanism to guide the rear edge of the door inwards and outwards, as it is closed or opened, is also shown in an accompanying illustration. It is, in fact, a hinged arm pivoted on the rear pillar, but which is not attached to the door. As the door is slid forwards, to close it, a vertical pin carried on a bracket mounted near its trailing edge engages a small hook on the outer end of the arm mechanism, and further movement of the door swings the arm forwards and inwards, pulling the rear edge of the door inwards until it seats firmly against the pillar. Movement of the door to the rear swings the arm, and therefore the rear edge of the door, outwards until the hook is pushed out of engagement

by contact with a stop; at the same time, a second hook engages another pin, mounted on the hinge itself, to hold the mechanism securely in position, ready for the return operation and to prevent it from rattling.

Among the other features of this vehicle that are of interest are the seating arrangements. Both seats are of the pedestal type. That for the driver has an adjustable spring suspension as well as being adjustable for height, longitudinal position and squab rake. The passenger's seat, immediately in front of the entrance to the rear compartment, can be tilted forward to give a clear gangway. These features, together with the neat dash facia arrangement, are shown in the illustrations.

As has already been mentioned, independent front suspension has been adopted for vehicles having a payload in the order of two tonnes by several manufacturers. The suspension layout adopted on a Kurier chassis was exhibited on a vehicle equipped with a forward control cab, which was lifted to disclose the engine, transmission and suspension. On this vehicle, the frame has side members of conventional channel section form. They are reinforced at the front by means of a second channel riveted inside each.

The upper wishbone, the spring and shock absorber are carried by a bracket bolted to the outer face of the frame, and the upper ends of these brackets on each side are braced by a box section member fitted between them and riveted to the upper flanges of the frame side members. This member is formed by a relatively shallow top-hat

to direct the air flow upwards through the matrix. The fan operates in a circular duct, which is directly connected to a shroud mounted on the rear face of the radiator. With this arrangement, it is necessary, of course, to have a relatively large clearance between the tips of the fan blades and the duct, because both the radiator and the engine are flexibly mounted independently.

In front of the suspension, engine and radiator installation is a tubular cross member. Welded to this cross member are two pressings, by means of which it is bolted to the frame side members. On one side, the pressing is of simple dished form, but on the other it is a complex box section comprising two flanged dished pressings welded together at the flanges. This larger fabricated assembly also carries the steering box and pedals. A three-piece, painted bumper is employed. It is attached to the front ends of the frame side members and to the ends of the tubular cross member.

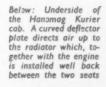
At the rear of the vehicle, a twin wheel layout has been adopted. Conventional semi-elliptic springs are employed. The two top leaves are wrapped round to form the eye at the front, while a slider arrangement has been adopted instead of a shackle at the trailing end. The two top leaves carry the load to the slider, while number four leaf is also extended into the slider bracket, but is curved downwards to bear against a bolt that is passed transversely through the bracket. This arrangement, of course, obviates rattle under rebound conditions.

The front track is 1,510 mm (approximately 4 ft 11½ in)



The Hanomag Kurier has a pedestal seat for the driver. This seat is spring mounted, for comfort when the vehicle is travelling over rough tracks, and can be adjusted for height, fore-and-aft position and for the sauab angle

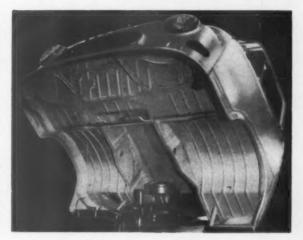
On this Hanomag cab the whole of the door panel below the waist is a single steel pressing except for the screwedon panel that carries the lock and window mechanism; the pocket also is a welded-on, one-piece pressing





section, with a closing plate riveted to its lower flanges. The lower ends of the brackets are braced by an inverted top hat section cross member extending between them and riveted to the lower flanges of the frame side members. An idler lever, for the two-piece track rod, is pivoted on the centre of this lower cross member. Beneath the frame side members, the lower wishbones are also pivoted on this cross member. An unusual feature of the arrangement is that the inner ends of the wishbone arms project inwards from their pivot eyes to form abutments for the rubber rebound stops. Bump movement is limited by stops that abut on the arms outboard of the pivots.

The radiator is carried on a four-point rubber mounting. Two of these mountings are disposed one on each end of the upper cross member that braces the suspension, while the other two are on a separate cross member bolted on the upper flanges of the side members, a few inches forward of the suspension. As can be seen from the illustration of the underside of the cab, there is a scoop in front of the radiator





Independent front suspension system of the Hanomag Kurier. A stout, dished plate is welded to the front cross member, which is locally reinforced, and the whole assembly is bolted to the frame side member

and the rear track is 1,444 mm (approximately 4 ft $8\frac{3}{4}$ in). A wheelbase of 2,500 mm (approximately 8 ft $2\frac{1}{2}$ in) is quoted. The vehicle is designed for an all-up weight of 3,870 kg (8,500 lb), the payload being 1,745 kg (3,840 lb). A 50 b.h.p. diesel engine is used as the power unit.

Henschel and Kässbohrer

Henschel-Werke G.m.b.H., of Kassel, have consolidated the progress that was demonstrated at the Frankfurt Show two years ago, and only minor detail alterations have been made to their chassis that were exhibited then. The air suspension system described in the December 1957 issue of Automobile Engineer is still employed for their tractor. It comprises a combination of leaf and air springs. All the engines of 150 b.h.p. and over manufactured by this firm are of the direct injection type, and this development is gradually being extended to the whole of the range. Like

most of the German manufacturers, Henschel are interested in turbocharging to increase power output and to obtain fuel economy. At present they are doing development work with engines fitted with K.K.K. (Kühnle, Kopp and Kausch) blowers.

Most of their vehicles have universal joints at the lower end of the steering column, as indeed have practically all the other makes of heavy commercial vehicle produced in Germany. The light alloy bus described in the November 1955 issue of Automobile Engineer is still in production, and is selling well in overseas markets, not only because of the ease with which it can be delivered in the CKD condition, but also because the resistance of the aluminium alloy to corrosion in very humid countries is better than that of steel.

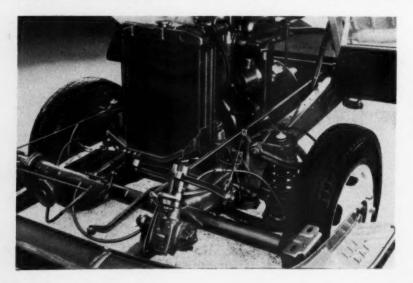
Karl Kässbohrer Fahrzeugwerk G.m.b.H., of Ulm/Donau, this year have exhibited a range of buses and coaches that are all noteworthy for their technical excellence. The vehicle with independent suspension and air springing on all four wheels, which was described in the December 1957 issue of Automobile Engineer, is still in production. An innovation is a lighter bus with the Torsilastic—rubber in torsion—independent suspension on all four wheels. Another of their vehicles has a combination of leaf springs, to carry the unladen weight of the vehicle, and air springs to allow for variations in loading.

Krupp

The firm of Fried. Krupp Motoren- und Kraftwagen-fabriken G.m.b.H., of Essen, have a number of interesting new developments. One is a two-stroke diesel engine, of 3.3 litres swept volume, which has been designed for use in either the vertical or the horizontal position. To suit this dual installation requirement, the Roots type blower is mounted on the front end of the crankcase and is driven, by means of a long torsionally flexible shaft, and gears at the rear end of the crankshaft.

This engine is a four-cylinder in line unit with an overhead camshaft, also driven from the rear end of the crankshaft. The inlet ports are uncovered by the piston at the bottom of its stroke, in the usual manner, while the exhaust ports are in the head and have poppet valves actuated by inverted bucket type tappets, on which the cams bear directly. Tappet clearance adjustment is effected by the interposition of shims between the tappets and hardened plates which bear on the valve stem ends.

An unusual feature is the adoption of individual injection pumps to supply each nozzle. The injection pumps are



A four-point rubber mounting carries the radiator of the Hanomag Kurier, and the steering box and pedals are on a pressed steel, fabricated bracket, which is welded to the tubular front cross member and bolted to the side frame of the chassis

mounted immediately above the injectors, on the valve gear casing, and they are driven by an extra set of cams on the overhead camshaft. It is stated that the principle reason for the adoption of this arrangement is that with a conventional pump it is not easy to obtain the high speed of operation required for this two-stroke engine, since the injection rate into each cylinder is, of course, once per revolution. Engine speeds of 2,600 and 2,800 r.p.m. are quoted. Among the other advantages of this arrangement are the fact that an extra drive for the injector pump is obviated and the delivery pipes to the injectors are all short and of equal length. The manufacturers state that this arrangement is not more expensive than a conventional injection pump with four elements. Deckel injection equipment was on the engine exhibited, but Bosch equipment is also available. Similar equipment has, of course, been used before on tractor engines.

Light alloy is employed for all the main castings, including the crankcase and cylinder block. Cast iron wet liners are fitted, and, to avoid electrolytic corrosion, they seat on tinplated sealing rings. The pistons, of course, also are of

cast iron.

At present the power output quoted is 132 b.h.p., with a blower pressure of 6.3 kg/cm² at 2,600 r.p.m. However, by increasing the bore from 97 to 100 mm and the stroke from 110 to 115 mm, and by increasing the speed to 2,800 r.p.m., it is expected that the power output can be increased to 145 b.h.p. The weight of the engine is 360 kg, so this would represent 2.48 kg/b.h.p. as compared with the 2.73 kg/b.h.p. of the standard unit. In English measurement, the figure

and 6 lb/b.h.p. With the two-stroke cycle, a plane four-throw crankshaft cannot be used, and this introduces difficulty with regard to

balance. On the Krupp engine this has been solved by the incorporation of two balance weights, one at the front end of the camshaft, as shown in an accompanying illustration, and the other on the crankshaft. These weights are appropriately phased to give the required balance.

for the weight is 790 lb and the other figures are 5.46 lb/b.h.p.

This engine has been fitted to the Krupp 501 chassis, which has air suspension at both front and rear. The all up weight of this chassis is 10,150 kg (22,300 lb). Perhaps the most interesting feature of this vehicle is its suspension. A tubular front axle is employed. Obviously, the reason for this is that the brake torque is reacted at one end only, and an I-section axle beam would be too flexible torsionally to react the load applied at the other end.

The axle is located by an N-system of trailing links pivoted under a cross member in front of the engine. Actually the N is in two pieces, one being a simple trailing link extending back, parallel to the side frame, on the right-hand side of the chassis, and the other two, which react the side loads, are connected at their apex to the left-hand side of the axle, as shown in the accompanying illustration. Brake torque is also reacted on the left-hand side, by means of these two arms and a vertical arm welded to the axle just inboard of their pivot point. The lower end of this arm can be seen immediately below the height regulator valve in the illustration; its upper end is connected by means of a horizontal link to the front cross member. Throughout the suspension system, both at the front and the rear, Freudenberg spherical rubber bushes are employed at points where articulation in more than one plane is required. The manufacturers of these joints are at Simrit Werk, Weinheim/ Bergstrasse.

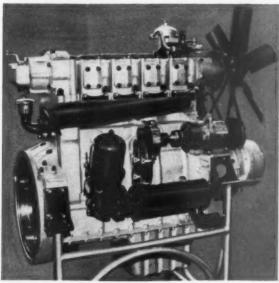
Double convolution bellows type air springs are employed, and the auxiliary reservoirs, or surge tanks, are mounted under the frame side members behind them. These reservoirs comprise two dished pressings welded one on top of and the other beneath a short length of large diameter tube. A height regulator valve and a telescopic shock absorber are mounted on the outer face of each side member of the

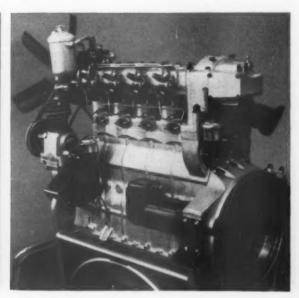
At the rear, four air springs, also of the double convolution bellows type, and four telescopic shock absorbers are



Left: Detail of the balance weight on the front end of the cam-shaft of the Krupp two-stroke diesel engine

Below: Left- and righthand sides of the Krupp two-stroke engine, which has an individual injection bumb for each of the cylinders





employed. The springs and shock absorbers are interposed between brackets on the frame and a relatively short yoke on each end of the axle. A single height regulator valve is employed in conjunction with a distributor valve to divide the air appropriately between each side of the vehicle. In principle, the distributor valve ensures that the air, when supplied to the springs, equalizes the pressures in them. Also, it ensures that when the regulator valve opens the exhaust to atmosphere, the air can flow out equally from all the springs. Longitudinal location of the axle is effected by two trailing links, one on each side, connected between brackets extending down from the side members and the axle. Two more links, connected to the top of the differential casing, take the lateral loads and help to react brake torque. The layout of these links is of V-form, as viewed in plan, the splayed ends being pivoted on a frame cross member. An anti-roll bar is also fitted on this chassis.

Mercedes

The Mercedes-Benz O 322 bus, for one man operation, will be in production towards the middle of next year. It is equipped with air suspension, the system being practically identical with that described in the December 1957 issue of Automobile Engineer. A recirculating-ball type steering gear is employed. This system is widely used by German commercial vehicle manufacturers.

Unitary construction has been adopted, the underfloor structure being welded to the framework of the body. Light metal is extensively used. The doors are operated electro-pneumatically, and can be controlled independently. They each comprise separate leaves which pivot about their own vertical axes while at the same time moving towards the pillars. With this arrangement, the doors occupy the smallest possible amount of space when they are open, and their inertia is minimized so that operation is rapid and silent. The speed of operation of doors is, of course, important in peak traffic conditions. To meet the requirements, without incurring the danger of trapping passengers between closing doors, a two-stage operational sequence has been adopted for closing them, and a separate button has to be pressed for each stage. When the first button is pressed the doors close rapidly but not completely, so that there is no danger of a limb or clothing being trapped immediately between the closing leaves. Depression of the second button finally closes the doors completely.

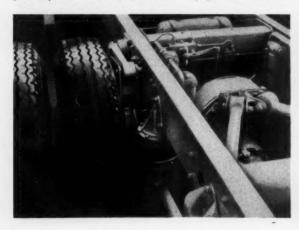
The engine is installed vertically at the rear, with its crankshaft axis parallel to the longitudinal axis of the vehicle. An interesting feature is the fan drive, which is effected

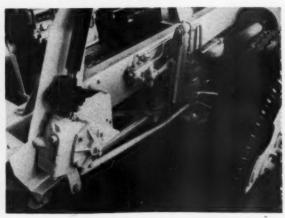
hydraulically by means of the Behr system incorporating a swash-plate type motor and pump. The advantage of this arrangement is that it obviates the need for a belt drive and, therefore, enables the radiator to be positioned more favourably. In this vehicle the radiator is on the extreme left-hand side, facing outwards. This leaves the rear end completely free for access to the engine and its auxiliaries. The employment of a hydraulic drive would be even more attractive if it were used for other units as well as the fan, thereby eliminating a number of mechanical drives, to effect greater economy, and enabling a more accessible layout to be adopted.

Another advantage of the hydraulic drive arrangement is that adjustment of the speed of operation of the driven component can be effected relatively simply. In this installation the fan speed is increased progressively as the engine temperature rises above a pre-set minimum level. This variation is effected automatically by a thermostatic control. In fact, the fan does not operate at all when the temperature of the coolant is lower than 84 deg C. The arrangement not only saves fuel consumption, by reducing the amount of power wasted in driving the fan, but also it enables the engine to be operating continuously at an almost constant temperature.



Of this group of three illustrations, the upper one shows the driver's seat and controls of the Mercedes-Benz O 322H bus illustrated at the top of the next page. Below, the left-hand illustration is of the air suspension system at the rear end of the Krupp 501 chassis, while the right-hand one is of the front suspension. A tubular front axle is employed because the whole of the brake torque is reacted only at the end that can be seen here





418



The Mercedes-Benz O 322H bus has twin parallel arms to carry each wiper blade for the curved windscreen. This arrangement enables the blades to wipe a large area, and to reach a long way round the curve on each side. The engine, installed vertically at the rear, has a hydraulic fan-drive

This latter feature should also effect a small saving in fuel consumption, and will reduce cylinder bore wear under certain conditions of operation.

Among the other interesting features of this vehicle is a compressed air actuated hand brake, which is operated by the movement of a small lever control on the dash facia. This arrangement conforms with the modern trend towards

reducing the effort required by the driver to operate controls and, thus, lessening fatigue. Either a four-speed synchromesh gearbox is installed or, if preferred, a new ZF Hydromedia gearbox, the 2HM-30 unit, can be supplied. This gearbox is similar to the 2HM-40 and 2HM-60 units except, of course, that it is smaller, since it has been specifically designed for high-speed diesel engines in the 100 to 120 b.h.p. class.

Sensitive Hydraulic Control

HYDRAULIC pressures of up to 1,500 lb/in² can be accurately controlled by the new Keelavite type 4879 valve. This is intended for the hydraulic actuation of industrial heavy-duty clutch and brake mechanisms, such as are used on cranes and winches, and for any similar applications where constant manual control is required. It is claimed that the valve is fully progressive, in that increased travel of the operating lever results in a corresponding increase in the applied hydraulic pressure; the greater this pressure, the greater the resistance felt by the operator.

The application of the full hydraulic pressure does not require an effort of more than 18 lb on the lever, so operation of the valve is not fatiguing. Three ranges of output pressures are available: 0 to 500 lb/in², 0 to 1,200 lb/in² and 0 to 1,500 lb/in². All port sizes are $\frac{1}{6}$ in B.S.P. The valves can be supplied singly or in groups of up to six, according to the application, and if desired they can be adapted for foot operation. They are manufactured by Keelavite Hydraulics Ltd., Allesley, Warwickshire.

New Trimming Material

IN THE description of the B.M.C. ADO 15 small cars, which appeared in the August 1959 issue of Automobile Engineer, mention was made of the use of an unusual beading section for the trimming of the externally flanged joints that are a feature of the body. This material, known as Claylastic, is a product of Howard Clayton-Wright Ltd., Wellesbourne, Warwickshire, and its use enables the joints to enhance rather than to detract from the appearance of the vehicle. Claylastic is an extrusion consisting of a strip of metal foil completely encased in cellulose acetate butyrate plastics material.

According to the application, this plastics shrouding can be either transparent or opaque. Where the transparent

material is used, the metal foil has a bright finish, which cannot tarnish; five standard finishes are available for the metal, simulating either chromium, copper, brass, silver or gold. Should an opaque covering be preferred, this can be prepared to match any desired colour, but it will be apprec-

These three examples of the range of Claylastic trimming show how the metal foil is encased in the plastics material



iated that such pigmentation is only an economical proposition if the quantities involved are large.

Claylastic is manufactured in a wide range of sections, to suit various purposes, and each section is available in a number of different sizes. Three typical sections are shown in the accompanying illustration. Full details of the range, together with applicational information, are given in a booklet on Claylastic, obtainable from the manufacturers.

Fluid Valves

DURING the past two years, Black Automatic Controls Ltd., of Leafield, Corsham, Wilts, have been developing additions to their range of valves for industrial handling of fuel oils and other fluids. The range includes both solenoid-operated and diaphragm-operated valves, in a variety of sizes. Details are given in the firm's leaflet LO, Issue 3, copies of which can be obtained from the manufacturers.



The Jaguar Mark 2 differs from the standard 2-4 and 3-4 litre models in several respects. Better vision results from the deeper screen, wrap-round type of rear light and enlarged windows. Alterations to the front suspension, and a wider rear track, have reduced the roll on cornering, and the interior of the car has been restyled

Jaguar Innovations

3.8-Litre Engine Available on Unitary Model; Front Suspension Modifications, Wider Rear Track and Larger Glass Area

OR 1960, the impressive Jaguar Cars range is augmented by the Mark 2 models. These are direct developments of the existing unitary construction 2-4-litre and 3-4-litre saloons, which continue in production. There are actually three versions of the Mark 2, since the 3-8-litre power unit becomes available in addition to the two smaller engines. In design, all three engines follow the familiar Jaguar layout, with part-spherical combustion chambers, and valves actuated by two overhead camshafts. The most important chassis change on these cars concerns the front suspension: this now has a higher roll centre, which reduces body roll on corners. A 34 in increase of the rear track also assists in this respect. The all-round range of vision from the interior and the appearance of the car are both improved by a considerable increase in the glass area, and the trim and associated equipment have been extensively modified.

As on most other 1960 Jaguar cars, the Mark 2 models are equipped as standard with Dunlop servo-assisted disc brakes on all four wheels. No changes have been made to the Mark IX saloon, nor to the XK150 models which, however, are now available with the option of the 3-4-litre or 3-8-litre engine, each in either of two forms. A limited-slip differential is standard equipment on the 3-8-litre versions of the Mark 2 and the XK150 cars.

The basic Jaguar front suspension layout—comprising semi-trailing wishbones, coil springs, an anti-roll bar and telescopic dampers—has not been altered in the Mark 2 cars, nor has the rubber-mounted beam carrying the suspension assembly and the steering box. However, the roll centre has been raised from $\frac{1}{4}$ in below ground level to $3\frac{1}{4}$ in above it. This has been effected by lowering the ball joints at the bottom of the steering swivel members, by $1\frac{1}{14}$ in, and by moving the upper ball joints outwards by approximately $\frac{1}{2}$ in, thus reducing the king-pin inclination from $7\frac{1}{2}$ deg to $4\frac{1}{4}$ deg. The pivots of the upper wishbones have been repositioned accordingly.

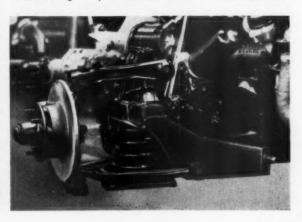
On the 2-4-litre Mark 2 model, by the adoption of the improved, B type cylinder head, the power output of the 83×76-5 mm engine has been raised from the 112 b.h.p. of the Mark 1 to 120 b.h.p., both at 5,750 r.p.m. By virtue of the use of this head, formerly fitted only to the larger engines, the torque has also been increased, from 140 to

144 lb-ft at 2,000 r.p.m. The compression ratio remains at 8.0:1. No changes have been made to the 83×106 mm 3.4-litre engine which, in its standard form as fitted to the Mark 2, develops 210 b.h.p. at 5,500 r.p.m. with a compression ratio of 8:1, and has a maximum torque of 215 lb-ft at 3,000 r.p.m.

Where still higher performance is desired, the standard 3-8-litre engine can be installed. This has the same stroke and compression ratio as the 3-4-litre unit, but the bore is increased to 87 mm; the power output is 220 b.h.p. at 5,500 r.p.m. and the maximum torque is 240 lb-ft at 3,000 r.p.m. As on the Mark 1 models, and most of the other cars in the range, there is a choice of a four-speed gearbox, with synchromesh on second, third and top, or Borg-Warner automatic transmission. Laycock-de Normanville overdrive is an optional extra with the manually controlled gearbox.

Although the outline of the Mark 2 body has not been altered appreciably from that of the Mark 1, the all-round range of vision has been increased by 18 per cent. The curved windscreen has been deepened, and its pillars are

The familiar Jaguar front suspension layout of semi-trailing wishbones and coil springs, mounted on a massive beam, is retained on the Mark 2 cars, but the geometry has now been altered to raise the roll centre



slimmer; also, the rear light has been enlarged and given a degree of wrap-round, and the lights of the rear doors have been extended beyond the line of the shut pillar, as on the Mark IX body. In consequence, the rear quarters of the roof offer much less obstruction to vision than did the earlier design. Other external changes include restyling of the radiator grille, and the recessing of the fog lamps into the frontal panel. The exhaust system tail-pipes are now on the left of the car instead of crossing over to the right, as hitherto.

Extensive alterations have been made to the interior, giving benefits in respect of both comfort and practicality. The front seats have been redesigned: they have a Dunlopillo base and their squabs incorporate folding tables. A steering wheel with two instead of four spokes is fitted, to give the best possible view of the speedometer and tachometer, which are now in front of the driver. On the Mark 1 cars, they were in the middle of the facia, a position that is occupied on the Mark 2 by the subsidiary instruments and the switches. Improvements have been made also to the heating and ventilating system, which now provides better distribution to the rear-seat occupants, by virtue of an outlet above the transmission tunnel, immediately behind the squabs of the front seats.

As was to be expected, the Mark VIII saloon has dropped

out of production, in favour of the more powerful Mark IX, fitted with the 220 b.h.p., 3.8-litre engine. A standard feature of this imposing car is the Burman power-assisted steering, of the type described in the February 1959 issue of Automobile Engineer. It is interesting to note that, according to the manufacturers, 85 per cent of the Mark IX Jaguars so far produced this year have been fitted with the optional automatic transmission.

The XK150 series continues to comprise three body styles: fixed-head coupé, drop-head coupé, and open twoseater. Previously, each has been available with the choice of the standard or S series 3-4-litre engine, but now similar versions of the 3-8-litre unit are added. The standard, twocarburettor engines of both sizes have already been mentioned in connection with other models in the range. More highly tuned, the S series engines have three carburettors, straightened inlet ports and a compression ratio of 9:1. The smaller of the two develops 250 b.h.p. at 5,500 r.p.m. and has a maximum torque of 240 lb-ft at 4,500 r.p.m.; the larger, the most powerful production engine yet offered by Jaguar Cars, provides an output of 265 b.h.p. at the same r.p.m., and a maximum torque of 260 lb-ft at 4,000 r.p.m. Since the open two-seater version of the XK150S has a kerb weight of 3,144 lb, its power: weight ratio is extremely high, at 189 b.h.p/ton.

Harperizing

Buffing Process for Finishing Components of Intricate Shape

A machine for finishing metal components has recently been developed by the Harper Buffing Machine Company of the U.S.A., and is now to be manufactured in this country by W. Canning and Co. Ltd. It improves the finish of the components by processing them in loose abrasives in a manner completely different from conventional barrel finishing. Innovations on this machine are claimed to reduce drastically the process times and to make possible the finishing of intricately contoured parts. Patents have been applied for, and W. Canning and Co. Ltd. have the sole rights outside the U.S.A. and Canada.

Fine loose abrasives are used in this machine, which is called the Harperizer. Centrifugal force holds the components and abrasive media together in a tight mass, in which the abrasives and the components being processed move in relation to one another. It is claimed that as a result, certain types of intricately contoured components can be uniformly smoothed to a finish comparable to that produced by conventional buffing methods, and that material removal is rapid.

The machine consists of a number of containers mounted on a large turret which revolves at speeds fast enough for the effective weight of the workpieces and media to be increased by 40 to 50 times by centrifugal force. The containers are mounted so that they are rotated on their own axes while the large turret is revolving. They are 37 in long, and their inside diameter is 11 in. Removable partitions can be used to form compartments to make it possible to process products of different sizes. All the containers have resilient, Neoprene rubber linings.

Balancing the rotating turret and the containers is important, because of the large centrifugal forces. Thus, machines with several containers mounted on the turret must be carefully balanced so that they are in equilibrium while the machine is operating. Both wet and dry media can be used, and that chosen should be fine enough to conform closely to the most intricate contours of the workpieces. Wet operations are successful for the deburring and radiusing of edges and for processing components too small or too light for normal tumbling operations.

As rotation of the turret begins, centrifugal force gradually increases until the turret reaches the normal operating speed. The considerable force produced compacts the abrasive and presses it against the sides of the container and against the components. Since the container is rubber-lined, the abrasive does not slide against its sides: instead, the compacted mass progresses with a caterpillar-like motion around the wall of the container.

As a result of the centrifugal force and caterpillar-like movement, the components are held tightly within the abrasive mass, which gradually slides relative to their surfaces and removes metal, to accomplish the finishing operation. Since the materials are kept compacted at all times, "waterfalling" is avoided and there is no falling or bombarding of workpieces with abrasives. Because the containers themselves are rotating, the position of greatest centrifugal force and the centre of stability constantly shifts within them, so that all the surfaces of the component are in turn subjected to approximately the same action. It is stated that as a result of the sustained high pressure and slow movement of the work and finishing medium, all surfaces are abraded to a uniform depth, and the cutting action is rapid so the processing time is short.

The Harperizer is probably best for finishing components that are difficult to process by conventional polishing methods. It is also useful if the component has complicated contours that make hand polishing impractical or if it is difficult to jig for automatic polishing machines. The machine is said to produce a highly polished surface, while at the same time preserving detail. Examples of the products that have already been successfully processed include cams, from 80 to 18 micro-in finish, without adversely affecting their contours, stainless steel flat-ware with an ornamental design, die castings and a range of plumbers' brassware.

New Perkins Engines

Description of Two Four-Cylinder Industrial Units, of 3·33 Litres and 3·15 Litres Swept Volume, Embodying a Number of Interesting Features

DETAILS have recently been released by Perkins Engines Ltd. of two new four-cylinder diesel engines for industrial purposes. They are designated the Four 203 and the Four 192, the figures being the swept volume in cubic inches. These engines are equally suitable for constant-speed operation or for variable-speed duties, for example in fork lift trucks and mobile cranes. In designing these engines, the manufacturers have aimed not only at long life and low running and maintenance costs, but also at torque characteristics appropriate to the intended application.

The only major difference between the two engines is in the bore, which is 91.4 mm in the case of the Four 203 and 88.9 mm for the Four 192. In each, the stroke is 127 mm. In the accompanying panel, the technical data for the larger unit are listed; the performance figures for the other are reduced approximately in the ratio of the swept volumes. The cast iron cylinder block and crankcase is common to both engines. Its sump joint face is on the horizontal plane through the crankshaft axis. The main bearing housings are well buttressed for rigidity, and the full-length water passages round the cylinders are of ample dimensions.

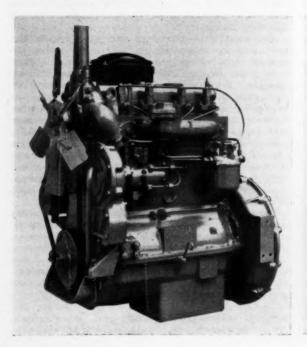
On the Four 203, the dry cylinder liners are of the thin-wall steel type, to enable the maximum practicable bore size to be obtained. They have chromium plated bores and are pressed into the block. This type of liner was first used on the C305 underfloor engine described in the November 1958 issue of *Automobile Engineer*. The smaller-bore, Four 192 engine has cast iron liners of normal wall thickness.

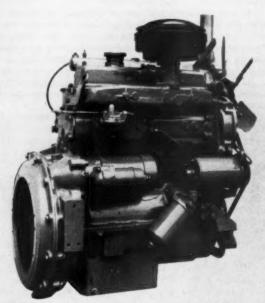
A forged chromium-molybdenum steel crankshaft is employed. Its main and big-end journals are induction hardened. To improve fatigue strength, the fillet radii of the rear main journal are burnished rolled. Axial location is effected by steel-backed lead-bronze thrust washers at the rear main bearing. The front end of the crankshaft is serrated to take a pulley, through which maximum engine torque can be transmitted, if desired, for power take-off purposes. There are five main bearings, of the copper-lead lined steel backed type.

The connecting rods are stampings of En. 17 steel, and their big-ends are split at right-angles to the major axis of the rod. In the big-ends, bearings of the same type as those for the main journals are employed, and the wrapped small-end bushes also are steel backed and lead-bronze lined. Since the connecting rod length is 9 in, the ratio of that length to the stroke is 1·8:1. The flat-top pistons are of high-silicon aluminium alloy and have a diameter: depth ratio of approximately 0·8:1 on the Four 203 engine; they carry three compression rings and one oil control ring above the gudgeon pin and an additional oil control ring below. Circlips retain the fully floating gudgeon pins in the pistons.

As viewed from the front, where the cooling fan is mounted, the camshaft is carried on the left, near the top of the cylinder block. It is driven from the crankshaft by a train of helical gears, including two idlers. The shaft is of high duty cast iron and its cams are chill-hardened. Its front bearing is of

Outwardly, the Perkins Four 203 and Four 192 engines are indistinguishable. The only major difference is in the bore, which is varied by the use of different types of cylinder liners. Other features include detachable covers to the combustion chambers, and three-way power take-off





the wrapped lead-bronze lined, steel backed type, but the other two are machined directly in the block. The front and centre bearings are lubricated under pressure, whereas lubrication of the cams and the rear bearing is effected by means of a cast-in trough, into which oil drains from the rocker gear.

With the high camshaft position, which is also employed on other Perkins engines including the C305 unit, push rods are unnecessary. Therefore, the rockers are actuated directly by the tappets, which are housed in the cast iron cylinder head. The tappets are of mushroom type, and their follower faces are chill-hardened; adjusting screws and locknuts are carried at their upper ends. Steel backed, lead-bronze bushes are fitted to the rockers, which are of fabricated construction and have hardened ends bearing on the tappets and valve stems. Oil is fed intermittently from the centre bearing of the camshaft to the hollow rocker shaft.

One inlet and one exhaust valve per cylinder, operate in cast iron guides. Inlet valves of En 18S, 1 per cent chromium steel, are used and the exhaust valves are of En 52 silicon-chromium steel: both are to B.S. 970. The valves are closed by duplex springs. As on most other Perkins engines, swirl type combustion chambers have been adopted. They are of approximately spherical form: the inner half of each is formed in the head casting and the outer half in a detachable steel cap secured by three studs to the side of the head. Each chamber is connected to the cylinder by a machined passage of tapered, swan-neck shape.

Injectors of two-spray design are fitted vertically in the head, the nozzles being positioned near the entrance to the swirl chambers. One spray is directed into the chamber, and the other towards the cylinder. A C.A.V. DPA distributor type fuel pump is employed. It is driven by the timing train and is mounted on the back of the timing case, on the opposite side of the block to the camshaft. In its standard form the pump embodies a hydraulic governor, but a mechanical governor can be specified, should a greater accuracy of control be needed.

The inlet manifold is an aluminium casting, and has provision for the installation of an oil bath air filter. Also, a boss is provided for the fitting of a Thermostart heater unit. The exhaust manifold is of cast iron, and the standard component has a two-bolt outlet flange on the top. However, manifolds with alternative outlet positions are available to suit particular applications. There are alternative positions,

SPECIFICATION

Number of cylinders, 4. Bore, 91.4 mm (3.6 in). Stroke, 127 mm (5 in). Swept volume, 3,334 cm⁹ (203.5 in⁹). Compression ratio, 17.4:1. Maximum b.h.p., continuous, 47 at 2,000 r.p.m. Maximum b.h.p., intermittent, 60 at 2,400 r.p.m. Maximum b.n.p., intermittent, 60 at 2,400 r.p.m. Maximum b.m.e.p., 98.6 lb/in⁹. Oil pump delivery, 318 gal/hr at 2,000 r.p.m. Oil pressure, 30 to 70 lb/in⁹. Oil capacity, 28 pints. Typical dry weight, 720 lb, including generator, starter, flywheel housing and air filter

too, for the belt-driven water pump. It can be mounted either on the front cover of the timing case or on the leading face of the cylinder head. A pressed steel fan can be fitted to the pump pulley if desired, and a thermostat is optional equipment.

Lubrication of the engine is effected by a pump of the eccentric-lobe type. The pump is bolted to the cap of the front main bearing and is driven by helical gears from the crankshaft. An orthodox oil distribution system is employed to serve the main and big-end bearings; the method of lubricating the camshaft and valve gear has already been mentioned. There is a gauze strainer at the pump suction inlet in the sump, and a full-flow filter with a paper element is mounted on the left-hand side of the cylinder block, towards the rear.

The power take-off can be from either end of the crank-shaft or from the camshaft, according to the application. Where the take-off is from the camshaft, a blanking plate is removed from the timing gear cover to permit the auxiliary drive housing to be bolted on. Provision is made also for an hour meter or tachometer to be driven from the rear end of the camshaft. Should a hydraulic pump be required, for power-assisted steering or other purposes, it can be mounted on the timing case, below the DPA pump, and the drive taken from the gear train.

For continuous running, the specific power output of the Four 203 engine is 14·1 b.h.p/litre, but for intermittent duties the higher figure of 18·0 b.h.p/litre is obtained. The mean piston speed at 2,000 r.p.m. is 1,666 ft/min, and the ratios of maximum torque: torque at maximum continuous power, and of speed at maximum torque: speed at maximum continuous power, are respectively 1·08:1 and 0·675:1. In other terms, this output is equal to 1·15 b.h.p/in² piston area and 0·065 b.h.p/lb engine dry weight.

Silicone Rubbers

IT HAS been announced by Midland Silicones Ltd. that their cold curing silicone rubbers are now in bulk production, whereas previously they were in experimental production only. This change will ensure both greater consistency and continuity of supply. Mention of the properties and uses of these Silastomers, as they are called, was made in the article entitled Automobile Applications of Silicones, which appeared in the July 1959 issue of Automobile Engineer. The materials are available in three grades, to suit various applications. Full details of these silicone rubbers are available from Midland Silicones Ltd., whose address is 68 Knightsbridge, London, S.W.1.

Work Study

WORK study is coming increasingly to be regarded as an important factor in management, not only in respect of the control of manufacturing processes but also as a means of ensuring good industrial relations. Moreover, its scope is

now being extended beyond the realm of industry, to such activities as farming, forestry and office work. The potentiality of work study and the best methods of applying it are outlined in a booklet entitled "Making the Most of Work Study". Copies can be obtained from the Secretary, Management Consultants Association, 4 London Wall Buildings, London, E.C.2.

Uses of Moulded Fibre

AMONG the components made of moulded fibre now being produced by Hawley Products Ltd., for the automobile industry, are instrument cowls and glove boxes. Other items under development include rocker gear covers, sumps, radio housings, seats and door panels. The Hawley material, which has a wood-pulp base, has a specific gravity one eighth that of steel, yet its ultimate strength can be as high as 7,500 lb/in². Also, it is non-resonant, does not chip and can have varying degrees of flexibility according to the specification adopted. The address of Hawley Products Ltd. is Garman Road, Park Estate, Tottenham, London, N.17.

Engine Performance Improvement

Latest Developments in Water and Water Alcohol Injection

K. WEISS, M.E. and J. W. RUDD, B.E.*

THE use of water as an internal coolant for engines operating on the Otto cycle principle, dates back to certain tests carried out by Benki in Hungary before 1900. Unfortunately, very little published data is available from this period. The theory behind the water injection process was only partly known at the beginning of this century, but it was known that water, when used as an internal coolant, had the power to prevent pre-ignition and detonation. In those years, detonation especially was a severe problem because of the low-octane value of the fuels available and the trend towards increasing the compression ratio of engines to obtain higher efficiencies.

In 1913, Professor B. Hopkinson, in England, carried out

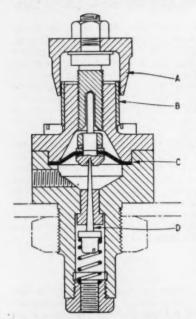


Fig. 1. Left: The control valve manufactured by George Kent Ltd. incorporates a diaphragm to prevent air from entering the valve body; this feature is essential to stop air from getting into the water system

A thimble; B sleeve; C diaphragm; D tapered needle

Fig. 2. Below, right: Direct reading lowrange flow meter, comprising a measuring element and a variable slope manometer

A flow scale; B temperature scale; C viscosity scale

extensive tests with water as an internal coolant for horizontal gas engines. Detonation in those engines was completely eliminated, and so successful was the method that Hopkinson eventually designed engines without water jackets, using internal cooling only. Oil engines with hot bulb ignition, designed in the middle 1920's for tractor work, were commonly fitted with water injection equipment to prevent detonation. The method of injecting the water ranged from manually controlled drip feed into the inlet manifold to power driven injection pumps.

Developments between the Wars

The developments in supercharged aircraft engines in the period from the end of World War I to the beginning of World War II brought water injection back to life. In 1938, M. S. Kuhring² published the results of his extensive tests on a supercharged Jaguar Mk. IV aircraft engine and he

reported a gain in power of about 21 per cent, with little change in specific fuel consumption. The water was injected into the air-fuel mixture before it entered the supercharger.

At the beginning of World War II, two publications appeared, one in Germany by K. Zinner⁵ and the other in U.S.A. by R. Wiebe, J. F. Shutz and J. F. Porter⁴. In both papers, a theoretical approach was made to find cycle temperatures and pressures, and engine efficiencies when water was injected in certain quantities into the engine cylinder. The American team calculated and drew Mollier diagrams applicable to a range of theoretical octane-waterair mixtures.

During World War II, water and water-alcohol injections, the latter to prevent freezing of the coolant, were used with great success on supercharged aircraft engines at take-off and at maximum flight speed. Intensive research was carried out at various laboratories in the U.S.A., Great Britain and in Germany, and some of the American results were published in N.A.C.A. wartime reports. Towards the end of World War II, however, water-alcohol injection was dropped, in service aircraft, owing to the possibility of water-alcohol being accidentally put in the normal fuel tank during operational refuelling, and because of the development of rocket-assisted take-off.

Recent advances

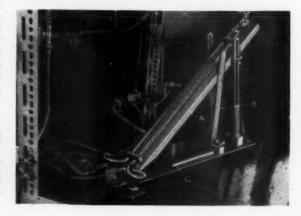
After World War II, experience gained from the injection of internal coolants into aircraft engines, was successfully applied to automobile and tractor engines. Work in this field was stimulated by the following:

 Scarcity and high price of fuels which could satisfy the octane requirements of modern high-compression car engines

(2) The possibility of further increase of the compression ratio of engines already using high grade fuels

(3) The hope of improving the performance and economy of existing and new engines.

Since 1945, many papers have been published on internal coolant injection. An interesting publication is that by A. T. Colwell, R. E. Cummings and D. E. Anderson, dealing with extensive investigations of water and various



The University of New South Wales, Broadway, Sydney, Australia.

water-alcohol mixtures on the performance and economy of truck engines. Power units with different compression ratios were used in conjunction with fuels of three different octane ratings.

In 1948, E. F. Obert⁶ published a paper on detonation and internal coolants. In this paper, the effects of internal coolants on the combustion process, on detonation and on performance were investigated. Since then, papers on water injection have been published from time to time and a fairly complete bibliography is given at the end of this

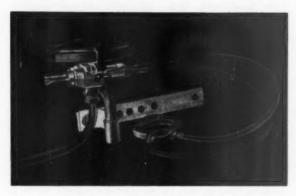


Fig. 3. T.T. Mist-Master, Model V3, manufactured by Kleinig Products. This new injector has a non-clogging metering jet, which is an advantage especially when hard water is employed in the injection system

Fig. 4. Below, right: Two cross sections of the T.T. Mist-Master, from which the principle of operation of the unit can be seen. All the components are of rust-proof materials to obtain a long operating life

article; this should prove to be useful to other investigators. During the last few years, research on water injection has been carried out at the following centres: the College of Aeronautics, Cranfield, England, where an excellent booklet was written by E. M. Goodger⁷; then at the Technische Hochschule, Braunschweig, Institut for Kolbenmaschinen, where Dr.-Ing. G. Choné⁸ wrote a dissertation on "Water injection into Otto-cycle motors"; and finally at the University of New South Wales, School of Mechanical Engineering, where the Authors were engaged in similar research. Questions as to the economy of water-alcohol injection, variation in cycle temperatures owing to water injection, and other allied problems were investigated. A special low-range flow meter was built and a new commercial injector calibrated and tested.

Theory

Under normal conditions, the combustion of a petrol-air mixture in the cylinder of an internal combustion engine is an orderly process of burning, which spreads out from the electrodes of a spark plug at a speed which may vary from 50 to 300 ft/sec. This relatively slow rate of travel does not produce an acute rise of pressure in the combustion space. When the flame front has reached the unburnt mixture in the farthest extremity of the combustion chamber, the latter burns slowly and the burning process gradually fades out.

During periods of severe operating conditions, however, such as high loading at slow speed, or engine overheating, the orderliness of the combustion process may be disrupted and very undesirable results produced. These combustion maladies are known as pre-ignition, auto-ignition and detonation, and they produce similar results so far as the engine performance is concerned, although they are caused by different processes. Of the three phenomena, detonation is the most undesirable and should be eliminated because

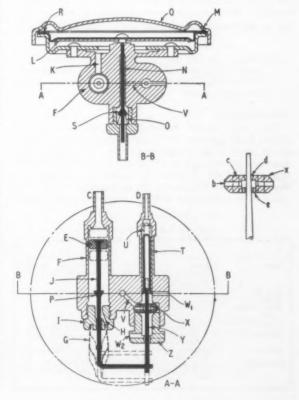
it is responsible for drop in engine output. If allowed to act for a long period, it may also lead to damage of engine components. Detonation, as it is known, will occur during the combustion process when the rise in temperature and pressure of the unburnt mixture is sufficient to produce autoignition. The increase in temperature of the unburnt mixture, often referred to as end-gas, is due to an additional amount of heat, received by conduction and radiation from the approaching flame front, whilst the increase in pressure is due to pressure waves transmitted at sonic speed to it from the burning section. When the auto-ignition of the unburnt gas occurs, the burning is practically instantaneous and has the nature of an explosion. Simultaneously, very rapid pressure increases take place, and they are responsible for shock waves, which impinge upon the cylinder and cylinder head walls, producing the characteristic high pitched knocking sounds.

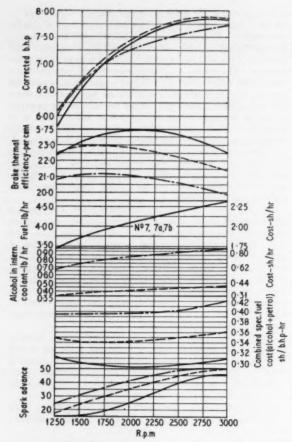
Other factors influencing detonation are spontaneous characteristics of the charge, the compression ratio, design of combustion chamber, engine speed, air-fuel ratio, the initial mixture temperature and pressure and the degree of spark advance. Detonation is most noticeable at full-throttle, slow speed operation, and will produce higher average combustion temperatures than those obtained during normal burning. In a detonating engine, it has been found that a greater amount of heat than usual finds its way to the jacket cooling water and a smaller percentage escapes with the exhaust gases.

To prevent detonation in an existing engine, without retarding the spark or using a fuel with a higher octane number, the injection of an internal coolant is the economical solution. The injection of such a coolant is responsible for:

(1) Slowing down the combustion process and hence the rate of temperature and pressure rise

(2) Lowering the maximum cycle temperature and pressure in the engine cylinder during operation





Test 7 _____ without internal coolant; 7o____ water+alcohol: fuel ratio 0.25: 1; Test 7b ____ water+alcohol: fuel ratio 0.50: 1 by weight

Fig. 6. Half-throttle tests with and without water-alcohol injection

(3) Cooling the end-gas and by so doing preventing it from reaching the critical temperature of auto-ignition. Water, with its high latent heat, is especially suited for such a process.

Test equipment

Tests were carried out with a Ricardo E6/S and an Austin A-40 engine. The specifications of these engines are as given in the accompanying table. A swinging field dynamometer was used to absorb the power of the Ricardo engine, while the Austin A-40 engine was coupled to a Heenan-Froude Dynamatic dynamometer, which was operated in conjunction with an electronic speed control.

TEST ENGINE SPECIFICATIONS

	Ricardo	Austin
Туре	Single cylinder, variable compressionengine, which can be used as a petrol or diesel engine	Four cylinder overhead valve engine
Bore, in	3.000	2.578
Stroke, in	4-375	3.500
Swept volume,		3 300
cm ³	506	1,200
Compression ratio	4.5:1 to 22:1	7:2:1
Speed range	1,000 to 3,000 r.p.m.	1,000 to 4,300 r.p.m.
Rated b.h.p.	11.4 at 3,000 r.p.m. with 7:1 comp. ratio	40 at 4,300 r.p.m.
Ignition	Magneto type KD1, 1	Lucas 12 volt coil and distributor
Carburettor	Solex downdraught, type 35 F.A.I., variable main jet	Solex downdraught, type 30 F.A.I., variable main jet

In both engines, the internal coolants were gravity fed into a special injector plate, situated between the carburettor and inlet manifold flange. Two separate tanks, one for water and the other for a water-alcohol mixture, could be connected to a float-chamber, which could be moved up or down on a special stand. The float-chamber was introduced into the coolant supply system to eliminate variation in head owing to consumption of the liquids during tests. With the Ricardo engine, water or water-alcohol was led to a very sensitive valve, manufactured by George Kent Ltd., Biscot Road, Luton, Beds. This valve, originally designed to control the flow of gases, incorporates a diaphragm to prevent air from entering the valve body, and it was for this reason that the valve was selected; other valves gave trouble due to air bypassing the gland and creeping into the water lines.

The opening of the Kent valve is controlled by the position of a micrometer spindle, which operates a needle valve through the medium of the diaphragm, Fig. 1. To cope with the required fluid quantities, the original needle had to be replaced by one with a larger taper, but the valve otherwise remained unaltered. From the control valve, water passed to the injector plate. Plastics hoses were used for all connections, so that the water flow and also any formation of air bubbles could be observed. A suitably arranged 8 ml pipette and a stop watch were used for measuring the flow rates of the internal coolants.

After completion of the tests on the Ricardo engine, a direct reading, low-range flow meter9 was built to speed up further tests. This instrument was found to be particularly suitable for the measurement of very small flow rates, even down to 0.1 pt/hr, which is about 10 drops per minute. It consists of a measuring element and a variable slope manometer. The principle of operation is that the head loss across a tube, through which a fluid is passing with laminar flow, is proportional to the flow rate, provided that the viscosity and temperature remain constant. The two tappings of the measuring element are connected to the sloping tube manometer, Fig. 2 This instrument can be used over a wide range of temperatures, provided the slope is set correctly on the corresponding temperature scale. Liquids of different viscosities can also be measured by altering the distance of the temperature scale from the hinge point and by substituting a modified temperature scale.

The instrument was built for a maximum flow rate of 9-60 pt/hr. Its measuring element is made from a copper tube 0-050 in bore, and the length between the tappings was calculated at 3-040 in. Results from accurate calibration tests were used to draw a curve converting flow scale readings into flow rates.

After passing the measuring element of the flow meter, the internal coolant enters a T-piece, which divides the flow between two control valves; one is the previously described valve and the second a simple petrol cock. Two valves in parallel are necessary because the diaphragm valve is not big enough to handle the water quantities required for tests in conjunction with the A-40 engine. Fine adjustment over a wide range of fluid flows, can be effected by suitable manipulation of both valves. Water is finally led to the injector plate.

In the second group of tests, an automatic water injection device was used for metering the fluid injected. For this purpose, the needle valve was closed and the petrol cock fully opened. The water injector was installed between the petrol cock and the injection plate. It was a T.T. Mist-Master, Model V3, manufactured by Kleinig Products, Sydney, Australia. This firm has been manufacturing power improvement devices for automobile engines for many years and has gained considerable experience with water and water-alcohol injectors. They claim that their new injector, Fig. 3, has a non-clogging metering jet—earlier models were

subject to blockages, particularly when used with hard water. A higher degree of water atomization is also claimed for this model.

The method of operation of this rather complicated injector can be seen from Fig. 4, which shows two cross-sections. To simplify the description of the operation of the injector, two phases will be selected: one, when the water supply is cut off, for manifold vacuums above $6\frac{1}{4}$ in Hg, and the second when water injection takes place, for vacuums below $6\frac{1}{4}$ in Hg. Two plastics tubes are fitted between the connectors C and D and the corresponding pipes, through the injection flange. The tube leading to C is $\frac{1}{16}$ in outside diameter, and transmits to the injector the vacuum in the manifold. The other tube is of $\frac{1}{8}$ in outside diameter and carries the water from the tube connector D to the injection flange.

Under the action of a manifold vacuum greater than 6¾ in Hg, the piston E is drawn to the end of cylinder F, pressing firmly against a sealing ring at the end of the cylinder and thus sealing off the manifold vacuum. Atmospheric pressure is admitted through a small hole H in the retaining nut I, and provides the force to move the piston. The conical spring G, made from phosphor-bronze, is then fully compressed by an L-shape piston rod J. Since the manifold vacuum is now sealed off, the pressure in the cylinder F is atmospheric and is transferred through a port K to the underside of a diaphragm plate L. Atmospheric

pressure is also admitted to the chamber above the diaphragm through a hole M drilled in the cover Q. Pressure leakages are prevented by sealing ring R.

The water supply to the injector enters at the tube connector P pressed into a retaining nut. If atmospheric pressure exists on both sides of the diaphragm, spring O raises the control rod N. Thus, the conical seat on this rod closes the tapered port S, and water is prevented from travelling any further into the injector body.

When the piston E is drawn on to its seat in the end of the cylinder F, the needle valve Y is pushed inwards by the piston rod J, which registers in an eye formed on the end of the needle Y. It also forces the sleeve T inwards against the spring U. The outside diameter of the tube T is only a few thousandths of an inch smaller than a corresponding counterbore drilled in the tube connector D. When the tube reaches this section it is immediately drawn to the bottom of the counterbore by the manifold vacuum, and thus is separated from the needle valve Y. Air can now enter the injector body by the two holes W, or W, and a very small amount of air bleeds into the manifold through a 0-018 in diameter atomizing hole in the sleeve T. This air is of insufficient quantity to cause any observable alteration in the air: fuel ratio of the mixture, even under the high vacuum conditions at idling speed.

When the throttle is opened sufficiently to reduce the manifold vacuum to a value below 64 in of mercury, water

Fig. 5. Half-throttle tests with and without water as internal coolant

Test 5 ______ without internal coolant; Test 5a _____ water: fuel ratio
0-25:1; Test 5b _____ water: fuel ratio 0-50:1; Test 5c _____ water: fuel ratio 0-75:1 by weight

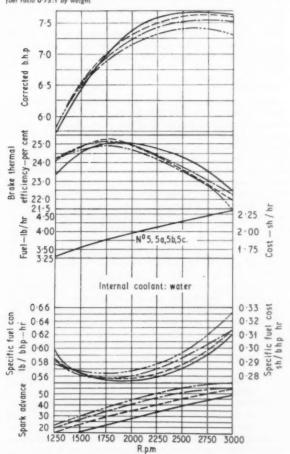
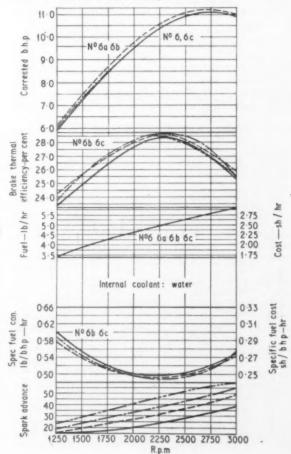


Fig. 7. Full-throttle tests with and without water as internal coolant

Test 6 ______ without internal coolant; Test 6a _____ water: fuel ratio 0.25:1; Test 6b ______ water: fuel ratio 0.50:1; Test 6c ______ water: fuel ratio 0.75:1 by weight



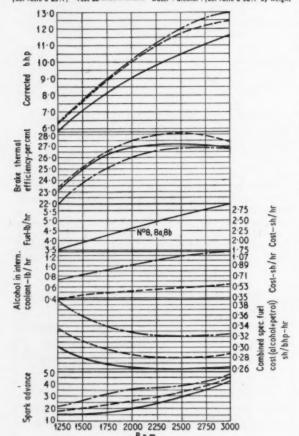
injection is initiated in the following manner. Since there is less capacity in the smaller than in the larger plastics tube, the pressure built up reaches the tube connector D before it reaches C. The sleeve T is immediately moved back by the compressed spring U and makes contact with the needle valve Y. Piston E moves back in the cylinder F to a new position, depending upon the actual value of the vacuum, and thus pulls the needle valve back a similar distance. The clearance of the piston in the cylinder is 0.003 in, and this value allows air to leak past the piston. The hole H, however, is sufficiently small to restrict the inflow of air and maintain a slight vacuum in the cylinder behind the piston. This vacuum operates the diaphragm, which is particularly sensitive to small pressure difference since it has an area of approximately 6 in2. The movement of the diaphragm opens the valve S, and water is admitted through the hole to the metering section of the injector.

From the hole V, the water flows through any of the four radial holes b into the valve insert X. It then flows out through either of the annuli formed by the holes d and e and the needle valve Y. The rate of flow depends upon the taper and position of the needle valve; hence metering is obtained. Air at atmospheric pressure is admitted through the hole W₂, whilst the pressure on the tube connector side of the valve insert is slightly below atmospheric owing to the influence of the engine vacuum. Hence both air and water flow through the two holes c to form a common stream entering the central portion of the sleeve T. More air is drawn into the injector through the hole W,

Fig. 8. Full-throttle tests with and without water-alcohol injection

Test 8 ______ without internal coelant; Test 8a _____ water+alcohol:

fuel ratio 0.25:1; Test 8b _____ water+alcohol: fuel ratio 0.50:1 by weight



and flows around the outside of the sleeve, the spring U tending to increase its turbulence. The water passes through the 0-018 in diameter hole at the end of the sleeve and is atomized by the action of the air, both inside and outside of the sleeve. The water-air mist then flows to the injection flange where it joins the ingoing petrol-air mixture to the engine.

When the engine vacuum becomes very low, the spring G pulls the operating rod J back until the tapered valve f seats in the retaining nut I. This cuts off the inward air-bleed through the hole H and the piston rod bearing, and thus ensures that sufficient vacuum will be maintained in the cylinder F to keep the diaphragm operative and the valve S open. As soon as the engine is stopped and no vacuum exists, the valve S closes, stopping further water injection.

Needle valves having a wide range of tapers are available, to make the injector adaptable for use on any engine. These needle valves are numbered according to their taper, No. 3, for example, has a taper of 0.003 in. The manufacturer recommends a taper of 0.001 in for a 500 cm³ motor, and an increase in taper of 0.001 in for every extra 500 cm³ engine capacity.

Regulation of the value of the engine vacuum at which the water flow cuts out can be effected either by altering the rate of the spring G or by changing the diameter of the hole H. Adjustment to the rate of water flow can be carried out by changing the needle valve for one of a different taper or by altering the diameter of the air inlet hole W.

The complete injector is constructed of rust-proof materials. Its body is of die-cast aluminium, the screwed fittings, piston and valve seat of brass, the operating rod, control rod, needle valves and springs of phosphor-bronze and the tube connectors of copper. The design of the injector calls for considerable manufacturing precision, and from evidence available, this has been maintained. All the bearing surfaces of the moving portions of the injector are of high quality materials, and a long operating life should be obtained.

Laboratory tests

These tests were carried out in two groups. The first one was done with a Ricardo E-6/S engine, which was run at a normal mixture strength. Readings were taken over a wide range of engine speeds, and at each speed the spark was advanced sufficiently to create trace-knocking conditions. These conditions were readily observed by watching the shape of the indicator diagram produced by an electronic instrument. All tests were done at two throttle openings, to give half- and full-throttle engine outputs. Tests were also repeated at compression ratios varying from 7:1 to 9:1, and using three internal coolant: fuel weight ratios, namely 0.25:1, 0.50:1 and 0.75:1. Economy figures were based on 3s 81d for a gallon of petrol and 7s 1d for a gallon of methylated spirit, both figures being in Australian currency. For all tests, a standard grade petrol, having an octane research number of 78 to 80, and a methylated spirit, consisting of 90 per cent ethyl and 10 per cent methyl alcohol, were used. The higher calorific values were found to be 19,640 and 12,640 BTU/lb respectively. Tests in group one were carried out with the object of investigating:

- Whether any improvements in power and economy could be obtained by injecting water or water-alcohol mixtures into the engine
- (2) The reduction in combustion chamber mean temperatures when using water at various mass ratios as an internal coolant
- (3) The influence of an internal coolant on the formation of carbon deposits on the piston crown and valve faces.

Tests falling into group two were carried out by using an Austin A-40 engine, and a comparatively lean mixture was

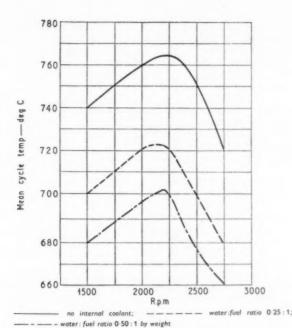


Fig. 10. The observed mean cycle temperatures in the combustion space

employed. Detonation, which, of course, occurs more readily at such a mixture, was suppressed by using water as an internal coolant. In most tests, the spark was advanced manually 30 deg in addition to the automatic advance, to make engine conditions more severe. Readings were taken for two throttle openings: full and \(\frac{3}{6}\)-full.

The following tests were carried out:

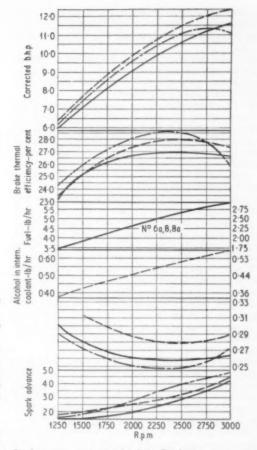
- To find the optimum water quantity, corresponding to maximum engine power and economy, at various engine speeds. This was done by altering the water rate manually
- (2) Calibration of a commercial water-injector and comparison of the results with the figures obtained in (1)
- (3) To compare the engine output figures without water injection with those obtained when using the new automatic Mist-Master.

Test results

Tests falling into group one were carried out at compression ratios 7:1, 7.5:1, 8:1, and 9:1. Results for the compression ratio 7.5:1 are shown in Figs. 5-9. Half-throttle tests, run first without internal coolant and then with water injected are shown in Fig. 5. The water: fuel weight ratios used were 0.25:1, 0.50:1 and 0.75:1.

From the graphs, it can be seen that best results were obtained with the 0.25 water: fuel weight ratio. A gain in power up to 1,750 r.p.m., relative to operation without internal coolant, was obtained. At higher speeds, however, a slight drop in power occurred. Obviously, the initial rise in power was due to the cooling effect on the charge, owing to vaporization, and to the reduction in work of compression. The reduction in engine power, especially with increased water: fuel weight ratios, was due to displacement of dry air by water vapour and probably to a reduction in rate of flame travel in the combustion space.

In Fig. 6, results of a half-throttle test are shown. A water-alcohol mixture, 50-50 by volume, was used as an internal coolant. A slight increase in power, derived from the thermal value of the alcohol, was noticed when the 0.25:1 water:fuel weight ratio is used. For the 0.50:1 weight ratio, an increase in power up to only 1,750 r.p.m. was found, while at higher engine speeds a reduction in



Test 8 _____ no internal coolant; Test 6a ____ water: fuel retio 0:25:1; Test 8a ___ _ water: alcohol: fuel ratio 0:25:1 by weight

Fig. 9. Full-throttle tests with water and with water-alcohol as internal coolant, compared with engine operation without any internal coolant

power occurred. The reasons for this phenomenon are the same as described before.

Curves for combined fuel costs indicate that at 2,000 r.p.m. operating costs have risen from 0.29 to about 0.34 and 0.4 shillings/b.h.p-hr respectively when water-alcohol mixtures at the two weight ratios are injected. Fig. 7 shows the graphs for the corresponding full-throttle tests, using pure water as internal coolant. The curve for test No. 6a indicates that a small gain in power and economy over the full speed range can be obtained when water at a 0.25:1 ratio is injected. The power curves for the two other internal coolant ratios, together with the no-coolant line, are close together.

Shown in Fig. 8 are the curves for the full-throttle test, with the water-alcohol mixture substituted as internal coolant. They demonstrate the increase in power derived from the alcohol in the coolant mixture. The minimum figures for the brake specific fuel consumptions expressed in terms of cost are: 0.26, 0.28 and 0.32 shillings/b.h.p-hr, the first one being in respect of the test without internal coolant.

In Fig. 9, the full throttle curves were redrawn, for water and water-alcohol at weight ratio 0.25:1, and for operation without internal coolant. From these curves it is possible to compare directly the full throttle results. For instance, at 2,500 r.p.m., the engine output with pure water injected increased by about 4½ per cent, while the specific fuel cost decreased by the same amount. When water-alcohol was

injected, power increased by about 9 per cent, but the specific fuel cost rose at the same time by about 8 per cent. To obtain these figures, those of test No. 8 were taken as 100 per cent.

It is interesting that most of the curves for spark advance have approximately the same form. Spark advance had to be increased with speed and rate of internal coolant flow, to maintain trace knocking conditions.

In Fig. 10, combustion space mean-temperatures are plotted against speed. A nearly constant drop of 40 deg C and 60 deg C respectively can be observed when water, at weight ratios 0-25:1 and 0-50:1, was injected. Temperatures were measured with a modified spark plug screwed into the cylinder head of the Ricardo engine. A thermocouple, consisting of chromel-alumel wires, replacing the centre electrode, was cemented into the porcelain.

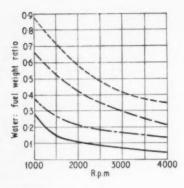
To investigate the influence of internal coolants on the formation of carbon deposits and valve life, the cylinder head of the Ricardo engine was removed before the main tests and the amount of carbon on the piston crown and liner top photographed, Fig. 11. These carbon deposits on the piston were left untouched and the engine reassembled. After 170 hours testing, a close investigation of the internal condition of the engine was made. It was found that the piston crown was practically free of carbon, Fig. 12, a sign that the carbon layer, purposely left on the crown, was disposed of and no other carbon particles deposited. The exhaust valve, although perfectly clean on the head, showed a slight amount of deposit on the face, but otherwise was in very good condition.

In another test, to determine the optimum water flow rates at full and 4-full throttle, water was injected at various water: fuel weight ratios ranging from zero to 0.50:1. This was accomplished by regulating the flow, by means of two valves described before. The ignition, in addition to its automatic advance, was advanced 20 deg when using an internal coolant ratio of zero, and 30 deg for all other ratios. Tests were repeated at the selected speeds, and brake load and fuel consumption figures were taken at each water: fuel weight ratio. Fig. 13 shows the relevant curves for corrected brake horse-power and specific fuel consumption at 2,000 r.p.m. Maximum power in this case was developed at a weight ratio of about 0.15:1; any further increase of this ratio brought also a reduction in power.

To find a master curve, water: fuel weight ratios, corresponding to optimum power developed at full throttle, are plotted against speed, Fig. 14. From the shape of this curve it can be seen that the internal coolant flow rate must be decreased with increase in engine speed if optimum conditions are to be obtained. Also, Fig. 14 shows three other curves, representing water: fuel weight ratios obtained when



14. Water: fuel weight ratios that give optimum engine power at full-throttle operation, with 30 deg plus automatic ignition advance settings



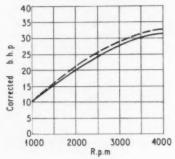


Fig. 15. Engine power developed with and with-out water injection for internal cooling

injection, ignition advance 20 deg plus automatic — with Mist-Master, needle number 2, igniti advance 34 deg plus aut

using the automatic water injector with needles Nos. 2, 3 and 7 respectively. For the Austin engine, the curve obtained with needle No. 2 fits the master curve best, although the water flow rate is still rather high,

Finally, in Fig. 15, two curves are shown: one is corrected brake horse-power plotted against speed developed by the A-40 engine at full throttle without internal coolant, and the second with the Mist-Master in operation. The two tests were run with the ignition manually advanced 20 deg and 34 deg in addition to the automatic advance. They demonstrate that a small increase of power and economy can be obtained in an automotive engine with a correctly designed water injector.

Conclusion

Investigations carried out in group one have furnished the following result:

(1) As has been known for many years, water can be used successfully as an internal coolant. From the three constant weight ratios applied, namely 0.25:1, 0.50:1 and 0.75:1, the first yields the most favourable results

Fig. 11. Carbon deposits on piston crown and liner just before tests Fig. 12. Carbon deposits on the piston crown after 170 hours testing



(2) Water injection makes it possible to raise the compression ratio of an engine up to 9:1 for operation with standard grade petrol

(3) At full throttle operation, using water at 0.25:1 ratio as internal coolant, a gain in power and economy of the order of 7 per cent at 2,500 r.p.m. can be obtained by increasing the compression ratio from 7:1 to 9:1 and advancing the spark until trace knocking occurs

(4) At full throttle operation and a constant compression ratio, for example, 7.5:1, an increase in power and economy of 2 to 3 per cent at speeds between 2,000 and 2,500 r.p.m., can be obtained by advancing the spark correctly and injecting water

(5) At half-thottle operation, a considerable gain in power can be obtained by increasing the compression ratio from 7:1 to 9:1. After advancing the spark and injecting water at 0.25:1 ratio, an increase in power of up to 13 per cent can be gained

(6) At constant compression ratios, in the range of 7:1 to 9:1, no gain in power and economy are found when using water injection and correct spark advance, compared with operation without internal coolant

(7) If a 50-50, by volume, water-alcohol mixture is used, the alcohol composition being as described before, a considerable gain in power will result. The economy, however, deteriorates markedly, owing to the high price of alcohol in Australia

(8) Water and water-alcohol mixtures will, to a great extent, prevent the building up of carbon deposits in the combustion space of an engine. Furthermore, the reduction in maximum gas temperature, brought about by the injection of an internal coolant will result in less burning, pitting and distortion of exhaust valves and valve seats. Thus, intervals between engine overhauls may be increased, representing another gain in engine operating economy

(9) The use of standard grade instead of super grade petrol for compression ratios up to 9:1 represents a further gain in economy of about 61 per cent, based on Australian petrol prices

Tests in Group two led to the following findings:

(10) The optimum water: fuel weight ratio is not a constant value and must be reduced with the increase in engine speed. It depends also on engine variables such as compression ratio, octane rating of the fuel, design of the combustion chamber, air temperature, humidity, mixture strength and selected spark advance. For the Austin A-40 engine, a ratio of about 0-30:1 is needed at 1,000 r.p.m., against 0.04:1 at 4,000 r.p.m. at full throttle

(11) Water injection is still advantageous at part throttle operation down to 3-full throttle, provided the ratios do not greatly exceed the optimum values

(12) Water injection is also advantageous when using lean air: fuel mixtures. The increase in power, however, is only small, and the engine output is below that obtained from a rich or normal mixture without water

(13) The Kleinig T.T. Mist-Master, Model V3 conforms to the general requirements that the water flow should decrease with increased manifold vacuum, and also that no water must be allowed to flow into the engine when the vacuum becomes zero. Cut-off occurs at 64 in Hg, a value which is reached at high engine speeds or during part-throttle operation

(14) Automatic injection of an internal coolant is a function of manifold vacuum only and bears, unfortunately, no relation to engine temperature. This has the disadvantage that water, when injected into a cold engine, will not be fully vaporized and if the car is

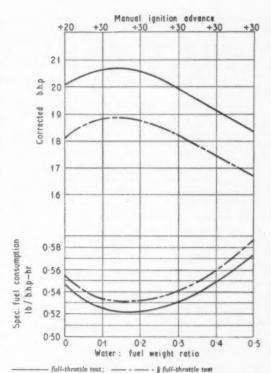


Fig. 13. Tests to find the optimum water flow rates at 2,000 r.p.m. Automatic advance was used in addition to the manual ignition advance

driven for only a short distance, will remain in the exhaust system and increase corrosion. injection will also prolong the warming-up process. Furthermore, water injected into an engine, just before it is stopped, will condense and intensify corrosion. A simple, thermostatically controlled device to start water injection after warm-up, or an overriding manual control, should be a valuable addition to the automatic water injector.

References

- B. HOPKINSON: "A New Method of Cooling Gas Engines", I.M.E. Proc., July 1913.
 M. S. KUHRING: "Water and Water-Alcohol Injection in a
- Supercharged Jaguar Aircraft Engine", Canadian Journ. of
- Research, August 1938.

 3. K. ZINNER: "Theoretische Grundlagen der Beeinflussung des Arbeitsverfahrens Verbrennungsmotoren Arbeitsverfahrens von Verbrennungsmotoren durch Wassereinspritzung", Forsch. Geb. Ing. Wesens, September 1940.
- R. WIEBE AND OTHERS: "Molliere Diagrams for the Theoret-ical Alcohol-Air and Octane-Water-Air Mixtures", Ind. and Eng. Chem., May 1942.
- 5. A. T. COLWELL AND OTHERS: "Alcohol-Water Injection", S.A.E. Journ. 53, 1945.
 6. E. F. OBERT: "Detonation and Internal Coolants", S.A.E.
- Trans., January 1948.
 E. M. GOODGER: "Water Injection in the Normally-Aspirated Piston Engine", The College of Aeronautics, Cranfield, Co A Note No. 78.
- "Wassereinspritzung in den Ottomotor", MTZ, 8. G. CHONÉ: July 1957.
- J. G. LAVENDER AND C. R. WEBB: "Direct Reading Low-Range Liquid Flowmeter", Engineering, May 1959.

Bibliography

- 1. E. L. BARGER AND J. L. GALE: "Distillate as a Tractor Fuel", Agric. Eng., February 1938.
- R. J. KOENIG AND G. HEISER: "Effect of Water Injection on R. J. KOENIG AND G. HEISER: "Effect of Water Injection on Cooling Characteristics of Pratt and Whitney R2800 Engine", N.A.C.A. A.R.R. No. 3—KO9, 1943.
 P. E. ADAIR: "Low Octane Fuel+Water=High Engine Performance", Aviat. Maint., February 1944.

 T. D. WEAR AND OTHERS: "Some Effect of Internal Coolants on Knock-Limited and Temperature-Limited Power as Determined in a Single Cylinder Aircraft Test Engine", N.A.C.A. A.R.R. No. E4H31, 1944.

A. H. BELL: "Continuous Use of Internal Cooling to Suppress Knock in Aircraft Engines Cruising at High Power", N.A.C.A. War. Pap. E55, August 1944.
 E. W. STEINITZ: "Water Injection", Automobile Engineer,

September 1944.

September 1944.
 R. J. BRUN AND OTHERS: "End-Zone Water Injection as a Means of Suppressing Knock in Spark-Ignition Engines", N.A.C.A. War. Rep. E72, September 1944.
 M. L. HARRIES AND OTHERS: "Effect of Water-Injection on Knock-Limited Performance of a V-type 12 Cyl. Liquid-Cooled Engine", N.A.C.A. War. Rep. E244, September 1944.

9. R. L. NELSON AND OTHERS: "Effect of Internal Coolant on Knock-Limited Performance of Liquid Cooled Multi-Cylinder Aircraft Engine with C.R. 6:1", N.A.C.A. War.

Rep. E260, June 1945.

10. C. F. KETTERING: "Fuels and Engines for Higher Power and Greater Economy", S.A.E. Journ., June 1945.

Alcohol Injection and Maximum Economy Spark Advance on Knock Limited Performance and Fuel Economy of Large Air Cooled Cylinder", N.A.C.A. War. Rep. E264, August 1045

M. R. ROWE AND G. T. LADD: "Water Injection for Aircraft Engines", S.A.E. Journ., January 1946.
 F. R. SPEED: "Alcohol-Water Injection", Bus Transp.,

January 1946.

January 1946.

14. W. P. GREEN AND C. A. SHREEVE: "Water Injection Spark Ignition Engine", A.S.M.E. Trans., July 1946.

15. D. C. EATON: "Cruising Economy by Use of Water Injection", S.A.E. Journ., February 1946.

16. E. J. WIEGAND AND D. W. MEADOR: "Advantages of Water Injection", Aero Digest, October 1946.

17. C. D. MILLER: "Roles of Detonation Waves and AutoLegities in Scart, Legitics Engine Knock as Shown by

Ignition in Spark Ignition Engine Knock as Shown by Photographs taken at 40,000 and 200,000 frames/sec", S.A.E. Trans., January 1947.

C. F. KETTERING: "More Efficient Utilisation of Fuels", S.A.E. Journ., July, 1947.
 R. MCLARREN: "Air Race Classic. Test Water-Injection Engines and Special Fuels", Automotive Ind. 97 (c), 1947.
 E. F. OBERT: "Water Injection Slows Combustion", S.A.E.

Journ. 55 (c), 1947.

P. M. HELDT: "Knock-Free Engine Operation on Low-Octane Gasolines", Automotive Ind., January 1948.
 R. C. MACK: "Automotive Dual Fuel System Saves High Octane Gasoline", Automotive Ind. 98 (3), 1948.
 C. H. VAN HARTESVELDT: "Economics of Anti-Detonant Injection Through New Automatic Octane Booster for Engines", Oil and Gas Journ., March 1948.
 J. C. PORTER AND OTHERS: "Boosting Engine Performance with Alcohol-Water Injection", Automotive Ind., May 1948.
 A. T. COLWELL: "More Effective Utilisation of High-Octane Fuels", S.A.E. Preprint, 1948.
 J. T. SMITH AND OTHERS: "Fleet Application of Anti-Detonant Injector", S.A.E. Preprint, 1948.
 R. I. POTTER: "Use of Anti-Detonant Injection in High Compression Ratio Engine", Petr. Ref., September 1948.
 A. M. ROTHROCK AND OTHERS: "Getting More M.P.G's from Octane Numbers", S.A.E. Journ., October 1948.
 VAN HARTESVELDT: "Anti-Detonant Injection", S.A.E.

"Anti-Detonant Injection", S.A.E. VAN HARTESVELDT:

Trans., April 1949.

C. H. VAN HARTESVELDT: "Progress Report on Anti-Detonant Injection in Automotive Engines", Pet. Eng., October 1949.
 R. WIEBE AND J. G. PORTER: "Alcohol-Water Injection for Spark-Ignition Engines", U.S. Dept. Agr. Publication AIC-240 Processed, 1949.
 R. W. SCOTT: "The Anti-Knock Quality Requirements of High Compression, Passenger Car Engines", Ind. Eng. Chapter 41 (10) 1949.

High Compression, Passenger Car Engines", Ind. Eng. Chem. 41 (10), 1949.
34. A. T. COLWELL: "Anti-Detonant Injection from the Fleet Operator's Viewpoint", S.A.E. Journ., March 1950.
35. J. C. PORTER AND OTHERS: "Alcohol-Water Injection for High Compression Tractor and Automobile Engines", Agric. Eng., February 1950.
36. L. C. PORTER: "Alcohol as an Arti Knock Agracian.

 J. C. PORTER: "Alcohol as an Anti-Knock Agent in Automotive Engines", Ind. and Eng. Chem., May 1952.
 R. WIEBE AND J. D. HUMMEL: "Practical Experiences with Alcohol-Water Injection in Trucks and Farm Tractors", Agric. Eng., May 1954.

Agric. Eng., May 1954.
38. C. R. KETTLEBOROUGH AND E. E. MILKINS: "Water Injection into I.C. Engines", Com. Eng., March 1955.
39. K. WEISS: "Calculation of Thermodynamic Charts", Automobile Engineer, October 1956.
40. K. WEISS: "The Effect of Water Injection on the Performance of an I.C.E.", Unpublished higher degree thesis, submitted to the University of N.S.W., November 1957.
41. J. W. RUDD: "The Calibration of a Commercial Water Injector", Unpublished degree thesis, submitted to the University of N.S.W., January 1959.

Management Conference

AT 8 a.m. on Tuesday, 17th November, the 14th National Conference of the British Institute of Management will be opened at Harrogate by the United States Ambassador, Mr. John Hay Whitney. A large number of papers, covering many aspects of management, will be presented at the conference, which lasts for three days. The titles of the papers include the following: "Selection of Senior Staff"; "Reaction of the Trade Unions to Automation"; "Management Approach to Standardization and Simplification"; "Resistance to Change in a Large-Scale Organization"; and "Production Problems in the Smaller Company". Further particulars are available from the B.I.M., whose address is Management House, 80 Fetter Lane, London, E.C.4.

Soldering Manual

AN EXCEEDINGLY comprehensive manual on soldering has recently been published by the American Welding Society. The manual has 176 pages, with 81 illustrations and 34 tables, and deals exhaustively with both the theory and practice of soldering in all its forms. Among the subjects covered are: the principles of soldering; solders and fluxes; joint design and preparation; equipment, processes and methods of soldering various materials, including stainless steels and cast iron, also nickel, lead, aluminium and magnesium, and their alloys. In addition, matters such as inspection and testing, printed circuits and safety measures are discussed, and the chemical compositions of solders and fluxes are listed. Copies of the manual are obtainable, price \$5.00, from the American Welding Society, 33 West 39th Street, New York 18, U.S.A.

Multi-Directional Conveying

CONSIDERABLE use is made in industry of the Collis TransVeyor units, wherever components have to be moved by hand in a number of directions. In principle, the components are rolled on large diameter balls inset in the track. The range has recently been increased by the introduction of a heavy-duty model, with a 2 in diameter ball and a loading capacity of 750 lb. For special purposes, a still larger assembly, having a 3 in ball and a capacity of 2,240 lb, is available.

These units follow the same principle as the smaller TransVeyor models: the load-carrying ball is free to rotate in any direction on a nest of smaller balls in a part-spherical housing. Retaining the ball is a cap which, on these larger assemblies, screws into the top of the housing; approximately of the ball's diameter protrudes above the upper surface of the cap. The cap contains a garter type seal, and the balls are lubricated by grease gun.

According to the particular application, the TransVeyor units can be recessed into the floor or bench, or they can be mounted on vertical steel tubes let into the floor. The manufacturers are J. Collis and Sons Ltd., and their address is Regent Square, Gray's Inn Road, London, W.C.1.

MODIFIED HUMBER CARS

Super Snipe with Larger-Bore Engine, Suspension Modifications and Disc Brakes: Minor Changes to Hawk Model

NTRODUCED about a year ago, the new Humber Super Snipe differed considerably from earlier models of this name, which were large cars, both in overall dimensions and engine swept volume. The 1959 version, on the other hand, was of little above medium size, and was powered by an engine of only 2.65 litres. Although this power unit was entirely new, the body pressings were similar to those of the existing 2.27-litre Hawk model. Because of the relatively small difference in engine size between these two cars, the increase of the swept volume of the Super Snipe to 2,951 cm³ for 1960 will cause little surprise.

To cater for the greater power of the modified engine, the front suspension has been improved in respect of roll stiffness, and disc brakes now replace the drum type on the front wheels. In other major respects, the specification of the Super Snipe is unchanged. It includes the choice of a three-speed gearbox, with or without overdrive, or automatic transmission; power-assisted steering is optional. Three body types are available: the normal saloon, the touring limousine—in effect, the saloon with a division—and the

station wagon.

The previous engine had square bore and stroke measurements of 82.55 mm. On the new unit, the stroke is unaltered but the bore has been increased to 87.3 mm, so the swept volume is larger by exactly 300 cm³. Also, the compression ratio has been raised from 7.5:1 to 8.0:1. There has been no change in the basic dimensions of the part-spherical combustion chambers or in the sizes of the valves or ports, but the piston crown formation has been altered slightly to provide the necessary small increase in clearance volume. As before, a Zenith downdraught carburettor is fitted; though still having a 42 mm choke diameter, it is of a different type from that of the 2.65-litre engine.

Other features of the engine include a forged crankshaft carried in four main bearings which, like the big-end bearings, are micro-babbitt lined. The single camshaft is chain driven and is relatively high on the side of the cylinder block. Since the valves are disposed at an included angle of 63 deg, there are two rocker shafts, and the induction and exhaust

valves are on the same side as the camshaft, the push rods

tracts are on opposite sides of the cylinder head.

Bucket type tappets are employed and, because the inlet

for these valves are inclined at a smaller angle to the vertical than are the exhaust push rods. The sparking plugs are mounted vertically in the head, and access to them is through sleeves spigoted into the top of the head and protruding through sealed openings in the rocker gear cover. To improve the cooling, a large diameter, eight-blade fan replaces the previous six-blade assembly, and it is driven at the same speed.

According to the manufacturers, the maximum gross power output of the new engine is 129 b.h.p. at 4,800 r.p.m., as against the 112 b.h.p. at 5,000 r.p.m. of the smaller unit. That the gain is approximately 15 per cent, for a swept volume increase of only 11 per cent, is attributable mainly to the raised compression ratio. As would be expected from the proportionately smaller valves, the increase of torque is greater than that of power: from 138·3 lb-ft at 1,600 to 2,400 r.p.m., the torque has risen to 162 lb-ft at 1,800 r.p.m., a gain of about 17 per cent. The maximum b.m.e.p. has gone up from 129 to 135 lb/in². A worthwhile improvement in acceleration should result from the higher torque and the makers state that the maximum speed of the saloon has increased to about 100 m.p.h.

When the standard transmission is fitted, the drive is transmitted through a 9 in diameter Borg and Beck clutch, with hydraulic actuation, to a three-speed gearbox, controlled by a lever on the steering column. The gearbox has synchromesh on all forward ratios, which are 1:1, 1.611:1 and 2.803:1; reverse is 3.187:1. Laycock-de Normanville overdrive is an optional extra and provides a step-up of 0.775:1 on top and second gears. The familiar Borg-Warner automatic transmission, embodying a hydraulic torque converter, is available at extra charge. With each type of transmission, an open, two-piece propeller shaft is employed. In the case of the manually controlled transmission, the ratio of the semi-floating, hypoid rear axle is 4.55:1, but with the automatic transmission the ratio is raised to 4.22:1.

The rear suspension layout follows orthodox lines in its use of semi-elliptic springs in conjunction with telescopic dampers. At the front, the suspension comprises semi-trailing wishbones and coil springs, again with dampers of the telescopic type. The diameter, and hence the stiffness,

The new Humber Super Snipe has restyled side decorations and a modified radiator grille. A larger-bore, 3-litre engine is now fitted, and the retardation from high speeds has been improved by the adoption of Girling disc brakes on the front wheels



of the anti-roll bar has been increased, to improve the cornering characteristics, and twin bump stops are now fitted. As on the previous model, the steering box is of the Burman recirculating-ball type. Power assistance of the steering is offered as an extra: it is made by Hydro-Steer Ltd. and is supplied with fluid under pressure from a Hobourn-Eaton pump, belt driven from the front end of the crankshaft. The servo jack is connected to the drop arm of the steering box. No ratio change is made when the servo is fitted.

Girling hydraulic brakes, with vacuum servo assistance, are employed. The discs on the front wheels have a diameter of 11½ in, and the total friction area of the pads is 24·16 in²; they sweep an area of 245 in². As on the previous Super Snipe, the rear brakes have drums of 11 in diameter and a shoe width of 2½ in. Their lining area is 94 in² and their swept area is 156 in². The pressed-steel disc type wheels are fitted with 6·70-15 in tyres.

It has not been found necessary to modify the unitary body structure. Several alterations have been made, however, to the interior. For example, the bench type front seat now provides greater comfort and more headroom, and the instrument lighting has been improved. More efficient windscreen wipers are fitted. The standard equipment includes a heating and demisting system, windscreen washers and reversing lamps, also a burr walnut facia panel, and folding tables in the back of the front seat squab.

Individual Reutter front seats, with reclining backs, are offered as an optional extra. The radiator grille is slightly altered and another external change is the provision, on two-tone models, of a flared flash, outlined by bright beading, along each side of the body.

Only minor changes have been made to the $2\cdot27$ -litre Hawk model. This has a four-cylinder engine with cylinder dimensions of 81×110 mm and combustion chambers of bath tub type; the compression ratio is $7\cdot5:1$ and the maximum power and torque figures are respectively 78 b.h.p. at 4,400 r.p.m. and $120\cdot4$ lb-ft at 2,300 r.p.m. The standard four-speed gearbox is now of similar type to that fitted to the $1\frac{1}{2}$ -litre Rootes cars, and provides ratios of $1:1,1\cdot392:1,2\cdot141:1$ and $3\cdot346:1$, with a reverse of $4\cdot239:1$. As on the Super Snipe, Laycock overdrive is available and there is the alternative of Borg-Warner automatic transmission.

The improved front seat is fitted to this model also, as are the new windscreen wipers. Changes have been made to the colour styling of the exterior, and the side panels carry a slender flash. The touring limousine and station wagon are produced in addition to the saloon. Both the Super Snipe and the Hawk have a wheelbase of 9 ft 2 in and the rear track in each case is 4 ft $7\frac{1}{2}$ in; the front track of the Super Snipe is 4 ft $8\frac{7}{6}$ in, whereas that of the Hawk is 4 ft 8 in. The kerb weights of the saloons are quoted by the manufacturers as 3,351 lb and 3,080 lb respectively.

Flight Missiles Number

ONCE again, our associate journal Flight presents its annual comprehensive, well illustrated survey of the world's missiles—from I.C.B.M's to small infantry types. Full descriptions and histories are given of every non-secret missile, plus photographs, technical drawings and basic data tables. Authoritative articles in this issue cover major aspects of missile design, development and use, and should be useful for reference purposes. Copies will be obtainable on 6th November, price 1s 6d, at all newsagents, or direct from Dorset House, Stamford Street, London, S.E.1.

I.C.I. Metals

COMPREHENSIVE technical information on some of the products of the Metals Division of Imperial Chemical Industries Ltd. is given in a new booklet entitled I.C.I. Sheet and Strip—Copper and Copper Alloys. The booklet has 52 pages, is extensively illustrated, and contains sections dealing with copper, brasses, bronzes and copper-nickel alloy. Copies are obtainable from Imperial Chemical House, Millbank, London, S.W.1.

Uses of Electricity

BECAUSE of its controllability, cleanliness and convenience, electrical process heating is becoming increasingly used in industry. To illustrate some of the potentialities of the method, The British Electrical Development Association has produced a film entitled Industrial Electric Heating. The film is in Eastmancolour, runs for 30 minutes and is available in both 16 and 35 mm sizes. It deals briefly with the theory of electrical heating, and extensively with the practice, including a number of automobile applications. Among the many firms and organizations that co-operated with the association in the preparation of the film are Fisher and Ludlow Ltd., The British Cast Iron Research Association, Standard Motor Co. Ltd., Imperial Chemical Industries Ltd., and also Wild-Barfield Electric Furnaces Ltd.

Another B.E.D.A. activity is the publication of books on specialized industrial applications of electricity. The first six titles have now been announced, and are as follows: 1, Higher Industrial Production with Electricity; 2, Lighting in Industry; 3, Electric Motors and Controls; 4, Materials Handling in Industry; 5, Electric Resistance Heating; 6, Induction and Dielectric Heating. Further details of the books and of the film, which is the most recent addition to an extensive !ibrary, are obtainable from The British Electrical Development Association, whose address is 2 Savoy Hill, London, W.C.2.

Bristol-ECW Double-Deck Bus

DEVELOPMENT of the Bristol Lodekka vehicle has now been carried a stage further, with the completion of the prototype vehicle, a 30 ft long double-deck bus, having a flat floor in the lower compartment with a single-step forward entrance. This new vehicle will shortly enter service with Bristol Omnibus Company, part of the Tilling Group. It has a body designed and built by Eastern Coach Works Ltd., and this body is mounted on a Bristol FLF type chassis, powered by a Bristol BVW 8-9-litre compression ignition engine. The chassis conforms to the latest Lodekka developments: it embodies a dual air-hydraulic braking system and rolling diaphragm type air suspension of the rear axle. Inside the vehicle there is accommodation for 70 passengers, seated 32 in the lower saloon and 38 in the upper one.

Industrial Filtration

THERE are few industrial processes in which filtration of one sort or another is not required. A new booklet published by Auto-Klean Strainers Ltd., Lascar Works, Hounslow, Middlesex, describes the comprehensive range of filters produced by the company and gives details of many applications. Entitled "Auto-Klean in Industry", the booklet has 40 pages, with numerous illustrations, and is well produced. Copies of this publication can be obtained from Auto-Klean Strainers Ltd., at the address given.

Albion Cab Sub-Frames

Standard Structures Available in Two Forms for Four Commercial Vehicle Models

A RECENT trend in commercial vehicle design is the integration of the cab with the body, to improve the appearance. In order to facilitate this method of construction, Albion Motors Ltd., Scotstoun, Glasgow, have introduced a cab sub-frame, available in two forms. These are for fitting to their Chieftain CH3, Clydesdale CD21, Reiver RE25 and RE27, and Victor VT19 chassis; they can also be fitted to the Victor VT17 chassis in its goods vehicle form. One version of the sub-frame comprises a bare supporting structure, and the other embodies the front half of the cab. Both types are shown in the accompanying illustrations.

The basic structure consists of a framework of 16 and



Above: The sturdy basic structure of the Albion cab sub-frame, which is supplied complete with the detachable engine cowling. Left: If desired, a half-cab, complete with windscreen, can be mounted on the sub-frame



14 s.w.g. steel sections, panelled mainly in 18 s.w.g. material. It is of mixed welded and bolted-up construction and is mounted directly on the chassis frame. The main components are the floor and its supporting frame, the rear bearer member, the engine cowling and the frontal section, of rectangular shape. Incorporated in the engine cowling is a quickly detachable top of asymmetric form, secured by toggle fasteners. Bolts are used to attach the main portion of the cowling to the framework, so that it can be removed to improve the access for any extensive maintenance work.

Undersealing is carried out where necessary on the subframe, and the whole assembly is given a coat of primer. The length of the unit is 5 ft 2 in, and it is 6 ft 8 in wide and 3 ft 2 in high. Its weight is approximately $1\frac{1}{2}$ cwt. Lamps are not included with this bare version, but they are supplied as standard equipment with the chassis, and their mounting is the responsibility of the coachbuilder.

The same basic unit is used in the second version, with the addition of the front portion of the cab. Mainly welded construction has been adopted for the front part of the cab, but parts liable to accidental damage are bolted on, to

simplify their replacement. The panelling is of 20 and 18 s.w.g. steel, while the supporting framework is of 16 or 14 s.w.g. material, according to the duty. Underscaling is applied and the complete assembly is painted with primer.

A windscreen of wrap-round type, complete with wipers, is included in the specification, as are a roof lamp and ventilator flaps and controls. The instrument panel is centrally disposed, and on each side of it are glove boxes. Head and side lamps are fitted when the unit is supplied mounted on a chassis. The unmounted dimensions of the complete sub-frame and half-cab are: length, 5 ft 6 in; width, 6 ft 8 in; height, 6 ft 2 in. According to Albion Motors, the weight is in the region of 4 cwt.

D.S.I.R. Technical Data

AMONG the Technical Digest sheets recently issued by the Department of Scientific and Industrial Research are the following: number 1017, a new type of silicon carbide heating element for electric furnaces; number 1019, an impact screwdriver; number 1023, means of measuring the air content of a sample of oil; number 1029, improved gas-air blowlamp; number 1031, electrostatic paint-spraying plant; number 1032, a visual system of preparing plant layout in factories and shops; number 1033, anti-static air gun; number 1035, thickness calibrator for sheet material up to ½ in thick; number 1037, a precision magnetic chuck for grinding machines. Copies of these digest sheets and others in the series, can be obtained from the D.S.I.R., 5 to 11 Regent Street, London, S.W.1.

Special Number

THE Show Review number of the Automobile Engineer will be published on Wednesday, November 25th. It will constitute a critical review of the more interesting exhibits and will have numerous illustrations of special features and design characteristics. This special issue can be obtained by order from newsagents throughout the United Kingdom, price 3s. 6d. net. Readers are reminded that it is necessary to make arrangements with a newsagent to ensure that a copy is secured.

................................



In the Chevrolet Corvair engine, a horizontally opposed, six-cylinder unit with air cooling, aluminium is employed for the crankcase, cylinder heads and clutch housing. The gearbox casing also is cast in aluminium

ONE of the outstanding features of the Chevrolet Corvair engine, described briefly in last month's issue of Automobile Engineer, is the extensive use of aluminium in the engine. The cylinder heads, vertically split crankcase, clutch bell housing and gearbox casing are all die cast in this material by a low-pressure process. Although some credit has been given by General Motors to Germany for assistance in respect of these castings, it does not appear to be generally appreciated that all the original work on the crankcase and gearbox shell was done in Great Britain. Not only this, but the German firm concerned is, in fact, a licensee of the British process, developed by Alumasc Ltd., of Burton Latimer, Northants.

The process was actually evolved during the early years of the war, when the Bristol Aeroplane Co. Ltd. was faced with the problem of manufacturing cylinder heads for the Hercules sleeve-valve engine at a very high rate. Those familiar with the company's earlier poppet-valve engines will recall that each cylinder head was an aluminium alloy forging, a large proportion of which was subsequently machined away to give the final form: for example, all the fins were fully machined.

If such laborious methods had been applied to the Hercules heads, with their multiplicity of radially disposed, closely pitched fins, the machine-shop capacity required would clearly have been enormous. The furtherance of the war effort therefore demanded an alternative method, involving the minimum of machining. Since it was essential that the components should have adequate strength, and that material wastage should be minimized, the answer clearly lay in pressure die casting rather than sand casting or gravity die casting. No suitable pressure process was then available in this country, so the task of evolving one was entrusted to three foundry experts: E. C. Lewis, L. Tinsley and G. Peters.

Their efforts were highly successful, as can be gauged from the fact that about 57,400 Hercules 14-cylinder engines were built during the war years. Although the low-pressure casting system evolved by this trio served its purpose well, it was hardly an economic proposition for peace-time production. Nevertheless, it was regarded by Mr. Lewis as sufficiently promising to warrant the formation of a

Corvair Engine Die Castings

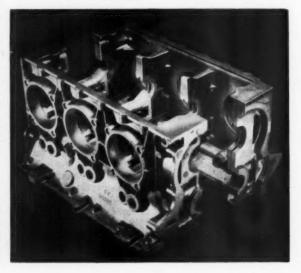
British Process of Producing Aluminium Low-Pressure Die Castings Used for the Chevrolet Compact Car

private company to develop it commercially. Alumasc Ltd. was founded in 1945 for that purpose. As a result of the intensive development work carried out by the company, the process is now applied to the casting of a variety of products sold in highly competitive markets. These products include beer barrels of various sizes from $4\frac{1}{2}$ to 54 gallons, kitchen ware and a number of small components, such as oil filter heads, coil housings and carburettor bodies, for internal combustion engines.

Some three years ago, a licence for the use of the Alumasc process was granted to the German firm Karl Schmidt, of Hamburg and Neckarsulm, a member of the Metalgesellschaft group. In a relatively short time, this firm was employing the system for the production of cylinder heads in quantity for the N.S.U. Werke. When General Motors decided that their new compact car was to have a power unit constructed largely of aluminium alloy, to avoid excessive weight at the rear, they found no suitable manufacturing process in the U.S.A. Their investigations in Europe took them to Karl Schmidt, where arrangements were made for the prototype cylinder heads to be made, using Alumasc methods. Since Schmidt had no experience of this type of crankcase casting, General Motors were referred to the licensors in England, in the hope that they could help.

Alumasc Ltd. confirmed that the crankcase halves could be

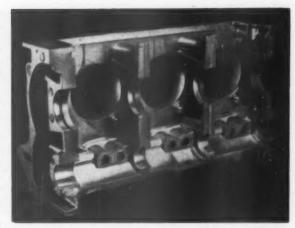
The complexity of the crankcase is shown by this illustration of a pair of the original castings, produced in Britain by Alumasc Ltd. by their own process, which is now used in the Chevrolet foundry in the U.S.A.



produced by their system, but the G.M. suggestion that they should undertake quantity production was unacceptable, owing to the rather problematic demand and the complete reorganization and expansion involved. They agreed to the production of the first set of dies and prototype castings, however, and one pair of these castings is shown in the accompanying illustration. The first gearbox dies and castings were also produced at Burton Latimer. All the production crankcase halves, cylinder heads and transmission housings are now cast in the ultra-modern and highly automated Chevrolet foundry at Massena, N.Y.

In the Alumasc factory, the aluminium is melted in a row of five Sklenar bulk melting units, which are oil fired. The pressure furnaces for the actual casting operation are of the Wild-Barfield induction type and are sunk into the floor to minimize heat and fumes. An important advantage of the low pressure system over gravity die casting is that a single runner of very limited size, weighing only about 1 oz, is sufficient, and no risers are needed. In consequence, the weight of aluminium to be melted is little more than that of the component, whereas with gravity casting it may be three times as great, resulting in considerable wastage.

Where molten aluminium alloy is contained under pressure in an iron crucible at high temperatures, contamination of the alloy by the iron tends to occur. To prevent this contamination, Mr. Lewis has devised and patented an ingenious arrangement. In this, the molten metal is held in a graphite or plumbago crucible that sits inside the iron crucible, which is pressurized to 5 to 10 lb/in².



An excellent finish was attained on the Alumasc castings. The camshaft tunnel and the tappet housings can be seen below the cylinder openings

Since the relatively fragile plumbago crucible is separate from its container, the pressures inside and outside it are equal, so the walls are not subjected to any bursting stress due to the pressure. This method has been found very satisfactory and is used in all the low-pressure furnaces employed on this project at the Massena foundry.

BRAKING EFFICIENCY RECORDER

ALTHOUGH the visual type of decelerometer is widely employed for test purposes by manufacturers of motor vehicles, brakes and linings, it has a marked disadvantage. This is that, if the best use is to be made of the unit, an observer has to accompany the driver on test runs. To overcome this difficulty, a new, mechanical recording decelero-



On the Mintex-Churchill recarding brake meter, a ball-point pen, fitted to the pendulum, makes a trace on a card held in an arcuate holder

arcuate holder on the machine. To avoid inaccuracies due to irregularities of the road surface, the pendulum movement is magnetically damped. The calibration is in percentages of g. As will be seen from the accompanying illustration, the

makes a trace on a calibrated record card mounted in an

As will be seen from the accompanying illustration, the recorder does not occupy much space in the vehicle, and it is said to operate accurately at any speed above 7 m.p.h. It is not unduly affected by front-end dip during braking, and automatically indicates any lateral bias caused by maladjustment or oil on the linings. The device is attached to its heavy base by means of levelling screws which, with the aid of a built-in spirit level, enable it to be accurately set at zero, even on a cambered road. If the road used has an incline, however, it is recommended that the test be carried out in both directions, using the same card and resetting the recorder before the second run.

Each Mintex-Churchill Brake Recorder is checked for accuracy on a specially designed electronic apparatus, to a schedule approved by the National Physical Laboratory. A certificate of satisfactory completion of the tests is issued with the machine. The address of British Belting and Asbestos Ltd. is Scandinavia Mills, Cleckheaton, Yorks.

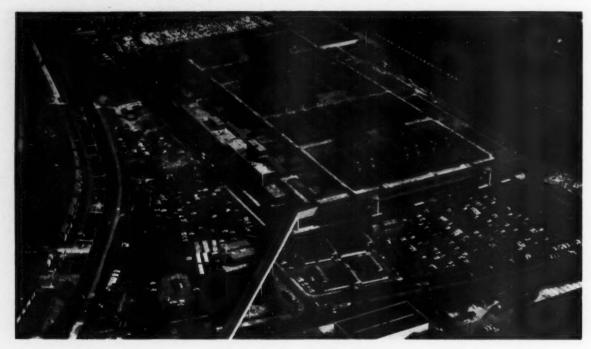
Dynamic Balancing

GOOD dynamic balance is essential for the majority of rotating components in motor vehicles and other mechanisms. The nature of the problems involved and the methods of investigating and rectifying unbalance are discussed in detail in a booklet entitled "Methods and Facilities for Practical Dynamic Balancing". This booklet deals with the application of the German Schenck wattmeter type of balancing machine, for which W. and T. Avery Ltd. are the sole agents in the United Kingdom and the Commonwealth. Copies of the booklet can be obtained from Avery Ltd., the address of whom is Soho Foundry, Birmingham, 40.

L

meter has been introduced by British Belting and Asbestos Ltd., the makers of Mintex brake linings. It is known as the Mintex-Churchill Brake Recorder, and has been approved by the Ministry of Transport for use in the compulsory testing scheme for old vehicles.

The operating principle of the decelerometer is very simple: retardation of the vehicle causes the movement of a pendulum, to which a ball-point pen is fitted. This pen



Aerial view of the new paint, trim, and assembly building. The body shells enter by the overhead tunnel at lower left

The Ford Paint Shop

Occupies the Whole of the First Floor of the New Paint, Trim, and Assembly Building, and is Equipped with Duplicate Systems Handling Body Shells for all Models

LAST major project in the vast, £75 million, expansion programme of the Ford Motor Co. Ltd., Dagenham, the recently erected Paint, Trim and Assembly Building has been completely equipped and brought into full-capacity operation. On a site area of 48 acres, the ground floor of the building is approximately 1,215 ft long and 630 ft wide. In this, all trim and assembly operations are carried out, all assembly material is received, and plant for the various services is accommodated.

The entire first floor, covering an area of 437,000 ft², is taken up by the paint shop. Body shells "in the white" are received from the body manufacture group building—the former Briggs body plant—on a King's dual-duty conveyor traversing a 725 ft long tunnel bridge. To ensure that oxidation of the unpainted shells should not occur when the conveyor is halted between shifts or at other periods, the tunnel atmosphere is controlled and held to a constant suitable temperature and humidity.

Shells for six different models, Popular, Prefect, Anglia, Consul, Zephyr and Zodiac, are handled in the plant which, in essentials, consists of two main systems of identical size and capacity. For convenience, only one system is detailed but the description applies equally well to the other. All shells undergo the same processing routine, phosphate coating (Bonderizing), slipper dip, primer coating, ground coating, final enamel coating, and two-tone treatment if required.

The system for the scheduling of models, colours, and

two-tone combinations, in conjunction with scheduling for trim and assembly departments, is a comprehensive procedure that is under continual review and adjustment. Starting from a projected yearly schedule, it is broken down to monthly, weekly, and daily schedules. The short schedule on which operations in the shop are conducted relates to the two working shifts only. Even this is divided into "early warning" and "late warning" notes of each vehicle assembly. These notes are prepared on manifolding machines at stations located on the shop floor and take care of individual hold-ups, repairs, or modifications and thus maintain the smooth flow of work on the production lines.

Phosphate plant

The main delivery conveyor bringing in the shells feeds into a buffer storage area. From there they are drawn as required and passed to a pre-clean deck to undergo a manual cleaning operation, concluding with a spirit wipe-off, before being passed to a six-stage Bonderizing line. This machine comprises an entry vestibule followed by an alkaline cleaning section, having 312 spray jets each delivering 2-7 gal/min, served by a pump of 900 gal/min capacity. A reservoir tank below the enclosure has a capacity of 3,800 gal and is maintained at a temperature of 170 deg F by means of steam-heated coils.

Next follows a drain section, and then the first hot-water rinse. A pump having a capacity of 550 gal/min serves a battery of 192 spray jets each passing 2-7 gal/min. The reservoir for this section holds 2,300 gal and is also steamheated to 170 deg F. In a following sequence is a drain section, a second hot-water rinse of identical specification, and a further drain section.

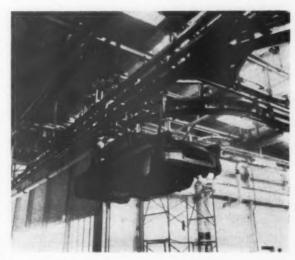
The phosphate stage is served by a pump of 900 gal/min capacity delivering 5 gal/min through each of 180 spray jets. Steam-heated coils maintain the solution at a temperature of 160 deg F. The 4,900 gal reservoir tank was specially designed to facilitate the removal of the sludge formed in the phosphating process. In the base of the tank are formed six conical wells, each approximately 6 ft deep, and from the bottom of these wells the sludge is drawn off slowly by means of a stainless-steel centrifugal pump. The sludge is discharged over an automatic paper filter unit which holds the sludge and allows the clear liquid to drain back to the reservoir tank. When the paper filter medium is fully loaded with sludge it is wound forward automatically to maintain continuous effective operation.

After the phosphate stage there is a drain section and then a cold-water rinse having 192 jets each passing 2.7 gal/min. The 2,800 gal tank for this section, of course, is not heated. A further drain section is followed by a chromate rinse, identical in specification to the first hotwater rinse. Only demineralized water, however, is supplied to the chromate tank. In the exit vestibule is a single-ring rinse of demineralized water with a slight chromate additive. This final rinse is pumped directly from the "Deminerolit" plant and is not re-circulated. The water drains into the previous chromate tank, serving as a water make-up.

The principal phosphate chemical is held in a 1,500 gal bulk storage tank located below the drain section of one of the phosphate lines. The filling pipework is run from the paint-mix building where a delivery pump is sited. All pipework is Durapipe plastics tubing, and transfer from the bulk storage tank to the reservoir tank is effected by a stainless-steel chemi-feeder.

Phosphate dry-off oven

Between the phosphate machine and the dry-off oven is a blow-off deck. The oven is 170 ft long and is designed to maintain the body shells at a temperature of 350 deg F for at least five minutes. Two gas-fired direct scroll heater units, having a total capacity of 6,000,000 B.Th.U/hr, heat the re-circulated air in the oven. Both ends of the oven are



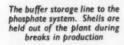
Body "in the white" entering paint shop from conveyor bridge

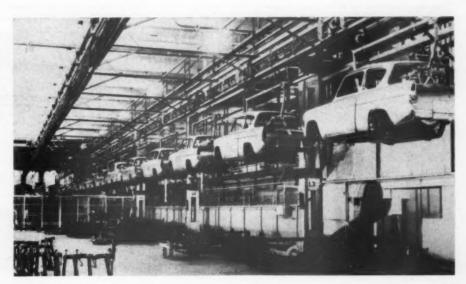
heat-sealed by fan-powered, high-velocity air seals. On leaving the oven, the shell passes through an efficient cooler booth equipped with axial-flow input and extraction fans.

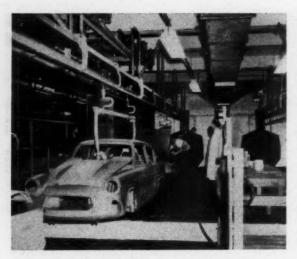
Alongside the phosphate oven and cooler are stripping lines to which shells can be diverted from within during breaks in production, and during meal breaks and between shifts as a matter of routine. Shells in the oven are passed to the stripping lines and shells in the phosphate machine to the oven, thus preventing the formation of rust during any interruption of the production flow.

Underbody dip

In the course of normal flow the shells are passed from the cooler to elevated open decks where the upper water and dust sealing and metal glaze operations are carried out. From this deck the shell is transported on an overhead conveyor round the end of the shop to the underbody dip system. This consists of a dip tank, 30 ft long and having a capacity of 3,200 gal of paint, followed by an enclosed drain tunnel, 150 ft long. The conveyor track undulates throughout this tunnel so that the paint swills and drains







Open deck for the upper dust and water sealing operations

from both ends of the shell, and to ensure that the interiors of hollow structural members are adequately coated.

Paint from the dip tank is continuously re-circulated through filters which remove any impurities. A large bore pipe runs from the base of the dip tank to a large dump tank in a concrete pit below the ground floor. In the event of fire, the paint is dumped automatically to the underground tank and the fire-suppression system will discharge CO₃ gas throughout the entire length of the dip and drain enclosure. Simultaneously, the pumps and fans are automatically stopped.

Primer spray booth

After underbody dip (slipper dip) the shells continue on the overhead conveyor to the primer spray booth, where they receive two coats of primer, red and grey, applied manually, wet on wet. The purpose of the two markedly different colours is to make immediately evident that, in each case, complete coverage has been effected.

The spray booth is 90 ft long, with entry and exit vestibules each 30 ft long, and is of the downdraught type.

Two air-conditioning plants on the roof each supply 80,000 ft³/min. to the booth. From them, air is ducted to the top of the booth and discharged evenly along the whole length of the booth through secondary filters. Fine control of the air supply is effected by means of perforated plate dampers at 2 ft 6 in intervals along the length of the booth.

Great care is taken to remove paint particles from the air extracted through the floor of the booth. The air is scrubbed in a Roto-wash booth before it is discharged to atmosphere. Every effort is made to provide the best possible working conditions for the operators.

Primer baking oven

From the primer spray booth the shells enter a baking oven 430 ft long, in which a peak temperature of 325 deg F is held for at least 30 min. This oven is heated in similar manner to the phosphate dry-off oven described earlier. Four gas-fired scroll-type air heaters provide a total heat input of 7,500,000 B.Th.U/hr. Following the oven is a cooler booth, as before.

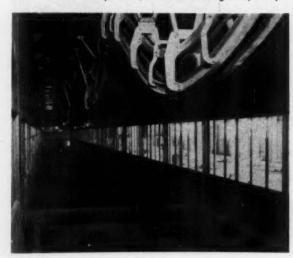
At this point the primed shell is prepared for transfer from the overhead conveyor to the two-strand floor conveyor. Two ski-type skids are attached to the underside of the shell, which is then turned round the end of the shop and dropped on to the floor line. All further progress through the shop is on floor conveyors. The first operation on the new line is the lower sealing of all seams and spotwelded flanges against the entry of dust and water—sealing of the upper part of the shell, it will be remembered, was effected before the slipper dip operation.

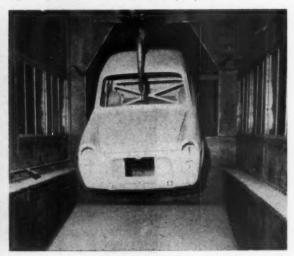
Primer wet sanding

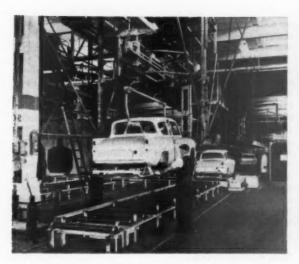
The shell then traverses a wet sanding deck, which is fed with clarified water, as described later, and at the end of the sanding operation receives a rinse in water direct from the "Deminerolit" plant. It then passes through a dry-off oven and a cooler booth to an open deck, where it is inspected and any blemishes in the primer coat are rectified. On a turntable the shells are turned through 180 deg so that they go nose first through the spray booths.

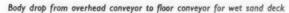
Shells scheduled for certain finishes are here diverted on to the ground coat line. This system comprises a spray booth, baking oven, wet sanding deck, dry-off oven and cooler booth of similar design to those described in the primer line. Again there is an inspection and, if necessary, rectification is made before the shell is allowed to proceed.

These two illustrations are of the primer slipper dip plant under construction. That on the left shows the dip tank, drain trays, and the undulating conveyor track, while that on the right is of a body entering the dip tank on a trial run of the conveyor system











The body being given the final rinse as it leaves the wet sand deck

Final enamel system

From primer and ground coat lines shells are passed over a lateral transfer system to the final enamel line. Each of the two spray booths consists of a 60 ft entrance vestibule, a 120 ft spray booth, and a 30 ft exit vestibule. Three air-conditioning plants, each having a capacity of 70,000 ft³/min, maintain atmosphere conditions in each system. Temperature and humidity of the input air are automatically regulated by an electronic control system supplied by Honeywell Controls Ltd. Air extraction and sludge removal is arranged on the same principle as those for the primer spray booth.

Enamels in fifteen different colours are piped to the spray booth. They are applied manually in two stages, wet on wet.

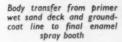
Enamel baking oven

On leaving the enamel booth, the shell passes into a final baking oven, 599 ft long, in which a peak temperature of 260 deg F is maintained for 30 min. Natural convection from gilled coils fed with steam at a pressure of 200 lb/in² heats the oven. The total heat output of these coils is

4,870,000 B.Th.U/hr. In each of the eight zones into which the oven is divided, the temperature is regulated by electronic thermostatic controls operating steam modulating valves. Heat and air seals are provided at each end of the oven, and at the leaving end the vestibule is supplied with clean, filtered air. After passing through a cooler the shell reaches an open deck where it undergoes a strict quality inspection. Monotone bodies passing this inspection are transported by conveyor to storage lines ready for selection and drop to the floor below for trim and final assembly operations, as called for by schedule.

Two-tone system

Bodies scheduled for two-tone finish are diverted to one of the two two-tone and repair systems. Each of these comprises a wet sand deck, dry-off oven, cooler, masking line, two-tone booth, baking oven, clean air vestibule, cooler, and final inspection deck. The spray booths and ovens in these systems are equipped to maintain the same high standards of air filtration, humidity, and temperature control as are applied to the final enamel system.







Inspection of primed bodies before transfer to enamel spray booth

Small parts paint system

Small component members of the body that are painted separately from the shell are processed in an area at the eastern end of the main paint shop. There is installed a complete system, resembling the main system for the body shells in general design and layout but, of course, to a smaller scale. The component parts are brought into a stock area by pallet train by way of a lift from the ground floor. From the stock the parts are selected to meet schedule requirements and hung on an overhead monorail conveyor which carries them through a six-stage Bonderizing machine of the type previously described.

After phosphating, the parts pass into a dry-off oven, and on leaving the oven certain parts are off-loaded from the conveyor for black enamel dipping. These parts are loaded on to flight bars on another conveyor, which submerges them in a dip tank and then carries them over a drain tray. Finally, they are passed upwards and into an overhead oven 200 ft long. The oven is gas fired and maintains the parts at a temperature of 400 deg F for 30 minutes. Protection against fire in the dip plant and oven is afforded

by CO₂ equipment and by dumping arrangements, in a manner similar to that already described in respect of the underbody dip plant.

Other parts continue on the conveyor over an aisle and are then off-loaded for either primer dipping or primer spraying in a booth similar to the shell spray booths. They then travel through a primer baking oven, over a dry sanding deck, and through a final enamel spray booth: this booth is 75 ft long, with entry and exit vestibules respectively 30 ft and 20 ft long. The parts are then baked in a three-pass, steam-heated oven which maintains them at a temperature of 260 deg F for 30 minutes.

The air conditioning plant serving the small parts enamel spray booth is similar in design to those for the body shell final enamel booths, and the same high standard of filtration and automatic control is maintained. Finished components from the small parts system are transported by pallet train back to the ground floor, for distribution on the trim and final assembly lines ready for fitting to the car bodies.

Sling washing system

In order to promote clean and efficient operation in the various paint systems, three washing plants are installed for the cyclic cleaning of hooks and slings. One is for the slings on which the shell is suspended on the overhead conveyor; one is for the ski-type skids on which the body rides on the dual-chain floor conveyor; and the third is for the hooks and hangers used in the small parts system.

These washers each consist of a long tank in which the suspension devices to be cleansed are immersed for a pass-time of five minutes in crisylic acid. After the washing operation, the parts are carried over a drain section and are then rinsed twice, once under high-pressure, cold-water jets and once under high-pressure, hot-water jets, before being returned to the loading areas of their respective conveyor systems.

Water supply and treatment

At an early stage in production planning, consideration had to be given, and decisions taken, on two major questions concerning the supply of mains water for the vast new paint shop. The first was the economic aspect. An hourly consumption of 25,000 gallons per hour was envisaged for the sanding decks, where the primer surfacer paint providing the base for the baking synthetic enamel is sanded down to a smooth surface. On a once-through basis, this

Left, enamel spray booth under construction, showing spray stations each with 15 spray points. Right, final enamel booth under operating conditions





would entail a consumption of 400,000 gallons per normal, two-shift, working day of 16 hours. With such a high rate of consumption there would be the continual hazard that a reduction in supply might be imposed, unpredictable in amount or in period. No other source of supply was available.

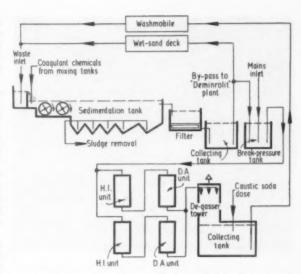
Secondly, a problem was posed by the fact that mains water—although pure and innocuous from the domestic consumer's viewpoint—contains dissolved solids whose presence handicaps many industrial finishing processes. When vehicle bodies, following spray painting, have been washed with mains water and allowed to dry, the dissolved solts are deposited on the drying surface. Removal is difficult, particularly as the salt deposits are normally invisible. If they are allowed to remain on a metal or painted surface, subsequently applied paint films will trap them and, since they are hygroscopic, they will absorb moisture through the top paint film, and this will cause blistering of the paint film in service.

The quality of water used during this stage of body finishing is, therefore, of vital importance. Of the total consumption referred to earlier approximately 6,000 gallons per hour would require to be highly purified to provide final rinses.

Accordingly, a thorough investigation into both problems was undertaken in conjunction with The Permutit Co. Ltd., Gunnersbury Avenue, London, W.4. The outcome was that it was decided that waste water could be collected from the wet sand deck and the final rinse, and then treated and returned for re-use, and that a proportion could be demineralized to provide pure water for the final rinse.

Reclamation plant

Following exhaustive laboratory tests to determine the best form of treatment to apply, a scheme was evolved embodying the comprehensive water treatment plant shown diagrammatically in the accompanying line illustration. Arranged in two sections, this plant operates on a continuous recirculation basis and enables a saving of 368,000 gallons of mains water to be effected over a 16-hour working day. At the same time it produces demineralized water for the express use of the paint spray final rinse section.

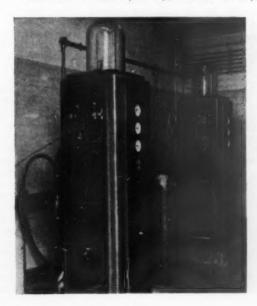


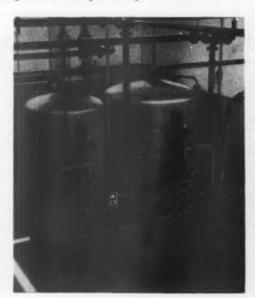
The flow diagram of the Permutit water treatment plant

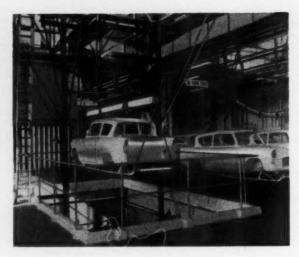
Used water from the wet sand deck and the paint spray final rinse is collected through a drain system and piped to a sump where it flows over a weir and is dosed with chemicals. The chemicals are administered in fluid form and consist of a lime suspension and a mixture of chlorine and ferrous sulphate. These materials destroy harmful bacteria and flocculate the impurities in the water. The flocculation process is assisted by revolving paddle wheels which agitate the water as it flows into sedimentation tanks. Here, coagulated suspended solids settle out as sludge, allowing partially clarified water to collect at the top. The sludge is removed periodically from the bottom of the tanks and discharged to drain.

The settled water flows from the top of the sedimentation tanks into rapid gravity sand filters which remove residual suspended matter. From here, the filtrate, now of normal

Permutit water treatment plant: left, Chlorinator and Sulphonator dosage control units; right, two-stage demineralization unit







The body drop to the trim lines, which are on the ground floor

mains water purity, is returned to service by way of a treated-water storage tank, a proportion being by-passed to the "Deminrolit" plant.

"Deminrolit" plant

Filtrate by-passed from the reclamation plant enters a break-pressure tank, where mains water is introduced to replace losses resulting from sludge removal and filter washing. The blended water then flows through two-stage "Deminrolit" units which are arranged in parallel pairs. Each pair comprises a hydrogen-ion cation exchange unit, removing mainly metal ions, and a "De-Acidite" anion exchange unit. The water passes first through the H-I units and then through the "De-Acidite" units. Dissolved salts present in the water are converted to corresponding acids by the material in the H-I units, and the acids, in turn, are absorbed by the material in the "De-Acidite" units.

Carbon-dioxide gas is liberated in the H-I units by the breakdown of bicarbonate salts, but remains in the water. The second stage of the demineralizing process is, therefore, the removal of dissolved CO₂ by passing the water through a de-gassing tower. Here, the water falls through an

upstream of blown air, which picks up the CO₂ and vents it to atmosphere from the top of the tower. The water collects in a tank at the foot of the tower, where a small dose of caustic-soda solution is administered by a feed pump. This neutralizes residual CO₂ and maintains correct pH conditions. The demineralized water is then pumped to the paint spray final rinses.

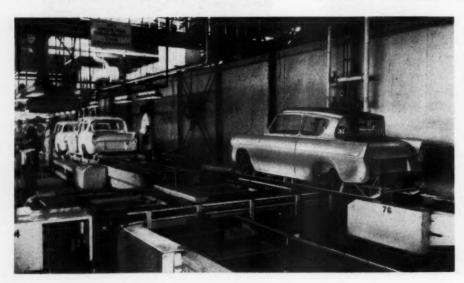
Periodical regeneration of the ion-exchange material in the "Deminrolit" units is effected by flushing the H-I units with diluted hydrochloric acid solution and the "De-Acidite" units with soda ash solution. The units are arranged in pairs so that one pair maintains full flow while the other pair is being regenerated. Chemicals required for regeneration are stored in bulk containers and diluted with water in automatically operated mixing tanks. When required, the regenerant solutions are injected hydraulically into the "Deminrolit" units. Normal outputs from the plant are 23,000 gallons hourly of recovered and purified waste water and 6,300 gallons hourly of demineralized water.

Conveyor systems

Body shells are received in the paint shop by overhead dual-duty conveyor and automatically indexed to one of two storage lines. From these they are fed into production lines at pre-set intervals dictated by the positions of call switches operated by the shell suspension sling. The phosphating machine, phosphate oven, underbody dip, primer spray and primer baking oven are all operated on this system, with automatic transfer points between each conveyor. Stripping lines are incorporated, into which shells can be diverted from the phosphate and underbody dip systems.

Immediately beyond the primer backing ovens, skids are attached to the shells and the shells are then decked on to floor lines by drop sections incorporated in the dual-duty conveyor track. These sections are completely automatic in operation, receiving a body shell from the main line and lowering it on to the floor conveyor. Subsequently, on reaching the upper limit of the track, the empty sling is ejected into the sling-wash system. All slings are passed through a washer to remove paint overspray, rinsed, and then returned automatically to the body-building plant by overhead conveyor system.

When decked on to the floor lines, the shells are passed through the primer system, wet sanding operations, ground coat, and one of two enamel systems and, when required, one of two two-tone and repair systems. Each paint booth and oven has its individual conveyor system into which



Transfer of finished bodies from final inspection to storage"conveyor for trim lines

body shells can be stripped during a close-down period, for cleaning the paint plant or to prevent oven bake and paint discoloration.

These stripping lines comprise a series of gravity idlers carried between twin-strand chain, so that bodies can be stored bumper-to-bumper. The stripping operation, once selected by remote push-button control, is completely automatic. On a restart, bodies are fed back into the main production flow to match up with those already in the system. At the end of the paint plant, bodies are automatically sequenced into the various model ranges and stored on floor lines prior to delivery by overhead conveyor system and body drop to the trim floor below.

All small parts pass through their separate phosphate and paint system by overhead power-pulled conveyors. This is a continuous flow system through primer spray booth, 2-pass oven, enamel booth, 3-pass oven and then on through a sling washer, involving a conveyor 2,000 ft long.

In addition there are two power-operated turntables, 45 powered rise-and-fall transfer tables, 10 fixed-height transfer tables, and eight dual-duty conveyor drop sections. Approximately 820 bodies in various stages of completion are in the paint shop at any time.

The following summary of paint shop conveyors gives an indication of the magnitude of the mechanical equipment of the shop.

CONVEYOR SYSTEMS

Conveyor type	Number of lines	Operational length, feet	Chain length, feet
Overhead dual-duty	27	7,500	16,500
Overhead power-pulled	3	4,000	4,000
2-strand chain	30	7,200	28,800
Double 2-strand chain	5	950	7,500
Roller flight	21	4,500	18,000
Powered rolls	3	90	
Gravity rolls	3	80	
2-strand chain transfer	14	520	2,080
	106	24,840 (4½ miles)	76,880 (15 miles

Paint mixing

Independent paint mixing and distribution systems are provided for primer and final enamel. The primer mixing room is located on the first floor of the building and houses six mixing units. These supply red and grey primer surfacer lines to the spray booths; two ground coat lines to their specific booths; and lines to the two underbody dipping machines, cold primer to the first stations of the primer body booths, and the small parts primer booth. The two main red and grey lines are supplied with paint at hotspraying viscosity; the heaters are located at the booths. Actually, twenty Aerograph DeVilbiss 6 kW paint heaters are installed at the two spray booths.

For enamel mixing there are fifteen units in a room sited outside the main building. These are each connected by flow and return lines to the two final enamel body shell booths, the two two-tone enamel booths, and the small parts final enamel booth. Each line is approximately 3,000 ft long. The paint in each system is mixed in a 100 gal tank equipped with an air-motor agitator and is then pumped into a 100 gal supply tank, also fitted with an agitator, for distribution around the paint lines by means of a Graco air-operated pump.

Coupled to the air supply to each mixing room is a stand-by compressor that is automatically brought into



View of the enamel mixing room, which is outside the main building

operation should the main air supply fail for any reason. These stand-by units are of a capacity sufficient to keep all the agitators in the mixing rooms operative and also to maintain the paint in the distribution lines circulating at reduced speed and pressure, thus obviating the risk of solidification.

Outside the main paint mixing room are four tanks, each holding 1,500 gal of thinners. From these tanks the thinners are piped direct to the mixing room where they are distributed, through meters and controllable-type dispensers, to the paint mixing tanks. In the distribution systems for primer and enamel there are approximately 11½ miles of circulating fluid lines. From a total of 86 spraying stations there are 842 take-off points, all furnished with Aerograph DeVilbiss spray guns.

Sludge handling system

Paint overspray in the spray booths is washed from the extraction air, as noted earlier. First the water in the system is treated with Peabody 5 MS compound which causes the paint particles, on mixing with the water, to form a floating sludge that is non-sticky. Pumps at spray-booth level cause this floating sludge to travel to the ends of the booth where it overflows down large diameter pipes to join two main trunk pipes below ground floor level. These mains conduct the sludge and water to separation pits located outside the southern wall of the building.

There are separate systems for enamel sludge and for primer sludge, the main sludge pipes being 24 in diameter and 20 in diameter respectively. Each system feeds into an underground concrete tank, 110 ft long, 10 ft wide, and 8 ft liquid depth. A third tank is reserved as a spare into which either system can be diverted during maintenance operations or in emergency. Sludge and water enters the western end of a tank and is induced to flow to the eastern end. There the floating sludge is skimmed off by a solid flight conveyor, and is deposited, in a reasonably solid condition, for reclamation or disposal.

Clear water is drawn from a low position at the eastern end of the tank by two pumps, each of 1,800 gal/min capacity, and delivered to the spray booths on the first floor. This returning water forms an excess that causes sludge to flow over the weir and thence to the underground tank. Each pumping system is furnished with one stand-by pump. Underground sludge pits are mechanically ventilated to avoid the accumulation of fumes given off by the paint sludge.

Aluminium Coating

An Anti-Corrosive Treatment with Decorative Possibilities

A NEW process for preventing rust and corrosion on steel and other metals, by the application of a thick aluminium skin, has been reported recently by National Research Corporation of Cambridge, Massachusetts. In an article in Business Week, it is stated that the inventors expect the new process to be used extensively in the protection of aircraft and automotive parts as well as consumer hardware. The technique, according to the article, is said to be similar to the vacuum coating method now used to give a purely decorative finish to articles such as mirrors, plastics toys and paper. In this process, aluminium is boiled in a vacuum, and the resulting aluminium vapour is condensed on the part to be coated.

Until now, vacuum coating techniques have not succeeded in building up aluminium coatings much more than one-millionth of an inch thick, and this is considerably below what is needed to produce an effective corrosion preventive. The N.R.C's new method, however, is claimed to yield a pure aluminium skin up to 0.004 in thick; this has been found in test applications to give superior protection. These thicker coatings are adherent, ductile and non-porous, and have been used successfully on a variety of materials such as high tensile steel, cold rolled steel, aluminium die castings and forgings, titanium, magnesium and cast iron.

The problems in thick-film aluminium coating have hitherto been to heat large vacuum chambers, to find a container suitable for holding superheated molten aluminium in these chambers, and to deposit the aluminium uniformly at controlled thicknesses. It is stated in the N.R.C. report that these problems have been solved. As in thin-film metallizing, the thick-film method can be used for processing individual objects in batches, and for the semi-continuous and continuous processing of rolls of flexible materials such

as steel strip.

In the car manufacturing industry, three areas are envisaged where the new technique might usefully be employed. These are (1) as an alternative to dipping body sheet steel components in molten metal; (2) as an anticorrosion coating for aluminium die castings and forgings of particular alloys; and (3) as a protective coating for cheaper stamped or pressed steel parts. Since the N.R.C. aluminium coatings would provide greater corrosion resistance than a chromium plated finish, at a comparable cost, it is believed that they could replace chromium for bumpers and for the trim on other automotive components. In addition, since the N.R.C. coatings lend themselves to the anodizing

process and to dyeing, they could simplify the colouring and matching of car accessories.

The need for protection against corrosion being of greatest importance in the aircraft industry, it is expected that the latter will be the first to use the new process. High tensile steel aircraft parts such as fasteners, fittings, and structural members are subject to corrosion from ordinary atmospheric attack, spilled fuels, lubricants, rocket blasts and salt spray or fog. At present, such corrosive inroads are lessened by one of two methods: the parts are either coated with aluminium by a dipping process or they are covered with cadmium by Both methods, however, have certain Aluminium dipping results in excessive electroplating. disadvantages. temperature of the component and, in certain instances, a consequent loss in tensile strength and the formation of an iron-aluminium alloy, which may be brittle. On the other hand, some electroplating processes may cause hydrogen embrittlement of the substratum high tensile steel.

N.R.C's preliminary experiments indicate that its new coatings are suitable for aircraft and some missile applications, where a high level of corrosion resistance is required at elevated temperatures. Several samples of $\frac{1}{18}$ in mild steel sheet, coated with approximately 0.0015 in of aluminium, have been bent 180 deg over a $\frac{1}{8}$ in diameter profile on a template. When magnified, the coating revealed no cracking or lifting in either the tension or compression areas of

the bend.

Corrosion resistance tests carried out by an aircraft company indicated that specimens coated with 0.5 mil to 1 mil of aluminium could withstand corrosive attack for about 600 hours under 20 per cent salt spray and salt fog conditions, while those coated with about 2 mils of aluminium lasted as long as 1,600 hours. Normal military tests require that materials resist such attack for only 96 hours.

These coatings can be used for ductile metallized steel strip and mild steel parts such as nuts, bolts, and washers. The thickness of the aluminium film on shaped parts such as bolt threads can be controlled. In these cases the coatings can resist relatively high temperatures and also can be anodized for abrasion resistance and decorative colour effects. The National Research Corporation now believes it has developed the thick-film vacuum metallizing process to the point where it can be applied on a commercial scale, under licence. N.R.C's manufacturing subsidiary, NRC Equipment Corp., will design, manufacture and install the required equipment for use with the process.

Treatment of Ferrous Metals

IT HAS been announced by the Pyrene Co. Ltd. that the chemicals and finishes necessary for the Endurion process of surface treating ferrous metals are now available in this country. This is a simple immersion process, applicable to zinc-phosphate coated, Parkerized surfaces, to which it imparts a dense, corrosion resistant finish of fine texture. In addition to the anti-corrosive property, said to be more than twice as effective as that of a Parkerized surface, Endurion also gives some improvement in wear resistance, with a negligible dimensional increase. The process is already widely used in the U.S.A., in industry and the army.

Normally, only one additional bath is required for use with a Parkerizing installation. However, if a colour finish is desired, a second bath is necessary. The colours available include grey, black, blue, green, olive drab and purple. Temperature control is not needed, because the process is carried out at the boiling point of the liquid.

Since Endurion penetrates readily into recesses and interstices, it provides overall protection of threaded and intricately shaped components. The surface is hard, does not chip or peel, and is compatible with organic finishes. Further details of the process and its operation are obtainable from the Pyrene Co. Ltd., Metal Finishing Division, whose address is: Great West Road, Brentford, Middlesex.

DIECASTING ECONOMIES



For the production of pressure or gravity discastings in any size or quantity, in a wide range of non-ferrous alloys, Fry's offer a complete service from design and prototype to the finished article.

By calling in the discaster at the design stage, the ultimate cost of a discast product can often be substantially reduced.

Fry's four works offer you almost unlimited production capacity and are situated to give you prompt service in every respect.

for a summary of the possibilities of pressure and gravity discasting, send for our Technical Bulletins.

The people with the facilities, capacity and achievements



FRY'S DIECASTINGS LTD., Prince George's Road, London, S.W.19 Telephone MITcham 2041 (6 lines) WORKS ALSO IN THE MIDLANDS AND NORTH-EAST

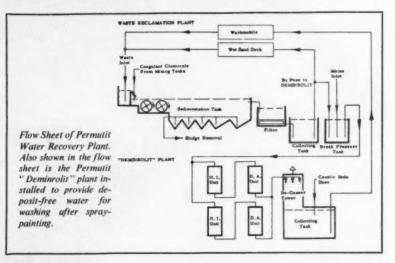
PERMUTIT Water Treatment Plant

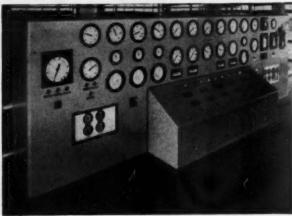
Water Recovery Plant Beats Water Shortage and Cuts Water Costs

Here are examples of how different water recovery problems have been solved by the installation of Water Recovery Plant by Permutit. These plants combine classical water treatment practice with the latest techniques in plant control.

400,000 gallons of fouled water recovered daily from Ford's Paint Trim and Assembly building.

The possibility of restricted supply of mains water, coupled with an increase in water charges, made water recovery an essential for this factory. Permutit investigated, carried out extensive laboratory tests and put up a scheme which met Ford's requirements completely. The scheme allowed for the purification for re-use of about 400,000 gallons of water daily. This water, mainly derived from the Wet Sand Decks and Washmobile departments is subjected to chemical treatment, sedimentation, flocculation and filtration, and employs Permutit plant specially designed for the job. A brief flow sheet of the plant is shown on the right.





Plant Control Panel at the Heinz Factory designed and constructed by Permutit. Recovering 110,000 gallons of fouled water hourly at the new Heinz factory at Kitt Green.

In the process of cooling hot cans of food, the cooling water is fouled by burst cans. To conserve water, Permutit put forward a scheme which would enable the cooling water to be recovered, purified and recirculated. The plant is basically a gravity sand filtration type, but designed for this special application and augmented by chemical dosing gear to make filtration more efficient and to provide for sterilization. Another feature of this plant is the fully automatic control for the filters: the control panel is shown here.

These two examples demonstrate Permutit's ability to deal with water recovery problems.

Water shortages and increased water costs make the provision of water recovery plants vitally important.

If you should have such problems, or can foresee them, contact Permutit now.

THE PERMUTIT COMPANY LIMITED

DEPT. D.M. 367, PERMUTIT HOUSE, GUNNERSBURY AVENUE, LONDON, W.4. TELEPHONE: CHISWICK 6431

Subsidiary Companie.

THE PERMUTIT COMPANY OF AUSTRALIA PTY. LIMITED 567-573 Pacific Highway, Crow's Nest, Sydney, N.S.W.

THE PERMUTIT COMPANY OF SOUTH AFRICA (PTY) LTD.
P.O. Box 6937, Johannesburg.

10N EXCHANGE (CANADA) LTD.

33 Price Street, Toronto 5, Ontario

Rapid, high-quality photoprinting

and no ventilating system required

The Ilford AZOFLEX Model 246 Combine printing and developing machine (formerly known as Model 46/35) is designed for use in the print room of the large drawing office. It does not produce unpleasant fumes and special ventilating systems are thus unnecessary, making it a simple matter to move the machine to a new position at any time.



- Exposure, development and print delivery synchronized for simplicity of operation.
- All controls conveniently located for rapid, effortless adjustment.
- Pneumatic-assisted handling of originals and sensitised material to obviate fatigue.
- Complete design co-ordinated for exceptionally high potential output.
- Excellent mechanical layout giving silent, vibrationless running.
- Comprehensive maintenance service available at nominal cost.

Capacity: rolls and cut sheets up to 42 in. wide, Printing speed: from 2 ft. to 30 ft. per minute, Lamp: H.P.M.V. quartz, 3,000 watt. Dimensions: height, 58 in., width, 72 in., depth (tray extended) 80 in. Weight: approx. 1,400 lb.

Subject to certain conditions, the majority of AZOFLEX photoprinting machines can be hired as an alternative to outright purchase.

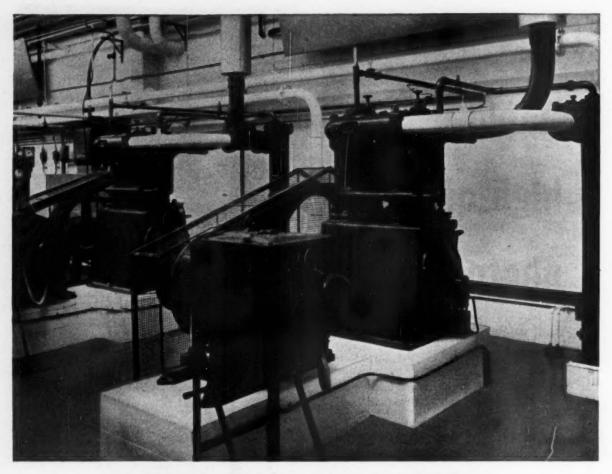
ILFORD

Azoflex

PHOTOPRINTING MACHINES & MATERIALS

Full details from

ILFORD LIMITED, INDUSTRIAL SALES DEPT. AZI8C ILFORD, ESSEX. TELEPHONE: ILFORD 3000



"BROOMWADE" for Reliability

In order to meet the manufacturing requirements of their high precision Engineering products, Messrs. Sperry Gyroscope Co. Ltd., paid meticulous attention to the planning of their new factory in Bracknell New Town, Berks.

Plant had to be highly reliable and efficient. The Air Compressors chosen were "BROOMWADE," proven for RELIABILITY & EFFICIENCY.

Illustrated are two of five Air Compressors supplying the air requirements. All are interlocked in the air main serving the plant.

"BROOMWADE"

Air Compressors & Pneumatic Tools

YOUR BEST INVESTMENT

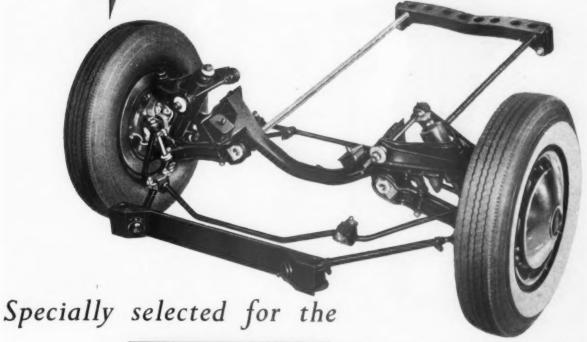
BROOM & WADE LTD., P.O. BOX NO. 7, HIGH WYCOMBE, ENGLAND

Telephone: High Wycombe 1630 (10 lines). Telegrams: "Broom," High Wycombe, (Telex).

697A SAS.

ESC

Torsion Bars



FIAT 1800 FRONT SUSPENSION



ENGLISH STEEL

FORGE AND ENGINEERING CORPORATION LTD

River Don Works, Sheffield

A WHOLLY OWNED SUBSIDIARY OF ENGLISH STEEL CORPORATION LTD



- Q What exactly do you mean by QD?
- D It's a piston for re-vitalising tired engines.
- Q Tired?
- After twenty or thirty thousand miles, especially on heavy duty work, most engines tire a little. Tiring is expensive. Your accounts are showing that several of your vehicles are heavy on oil. Your drivers are complaining of low power and are taking longer over their journeys. Fundamentally, that's largely due to cylinder wear.
- Q In other words, you think I need new pistons?
- Probably. It depends upon the amount of wear involved. It is possible that the trouble can be cured with Duaflex alone.
- Q Duaflex?
- D The D part of QD. When piston wear is not

excessive you can fit Duaflex Rings to existing pistons to compensate for cylinder wear, restore power, cut oil consumption, and give thousands more miles of lively performance. All for about a sixth of the cost of a replacement engine.

- Q And if the pistons are badly worn?
- D Then new QD pistons are the answer, complete with Duaflex and Quickseat Top Rings. Your service engineer can determine the best course after measuring the bores and pistons. You can rely on these products curing the trouble.

 Wellworthy have been specialising in this field almost since motoring first began.

 Q.E.D.

If you have got vehicles in your fleet running up your lube oil bills, heavy on fuel and doing far too much low gear work, fit QD. Write now for literature and address of nearest Stockist to Dept. A10



WELLWORTHY LTD LYMINGTON HANTS





There won't be any trouble with that Sir.

The chrome is plated onto DUPLEX NICKEL—a new process consisting of two coats of nickel which provide a corrosion-resistant foundation.



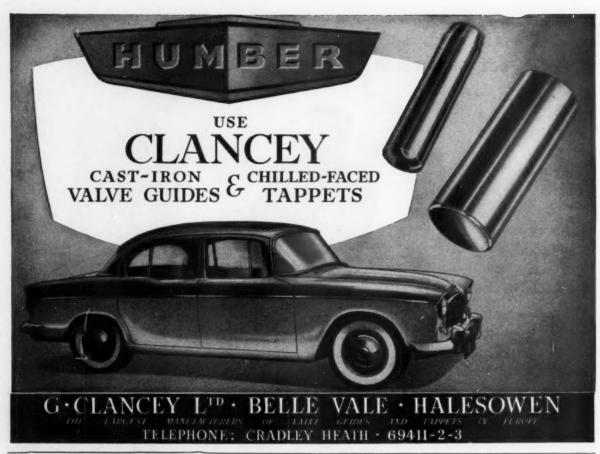
DUPLEX

NICKEL COATINGS

Good CHROME is dependent on good NICKEL



GT. HAMPTON ST. BIRMINGHAM 18 . LONDON & SHEFFIELD





says Will the Welder

"It's stronger than original cast iron!"

Process 101 is the new method of jointing cast iron by low-temperature bronze-welding—and it produces joints far and away superior to any other method. By means of the new Sifbronze 101 rod and the new Sifbronze 101 flux, the old sluggishness of flow across the joint face has been completely eliminated. Result is a far greater degree of "penetration" of bronze into the parent metal and "peeling" of joints is now a thing of the past. A Process 101 weld is definitely stronger than the original cast iron!

If you fill in the coupon we will send you full details and a free sample.

!	To:
	SUFFOLK IRON FOUNDRY (1928) LTD., Stowmarket, Suffolk.
	Please send me Process 101 Leaflet and a free sample of 101 Rods.
	NAME
	ADDRESS
	AFIAI

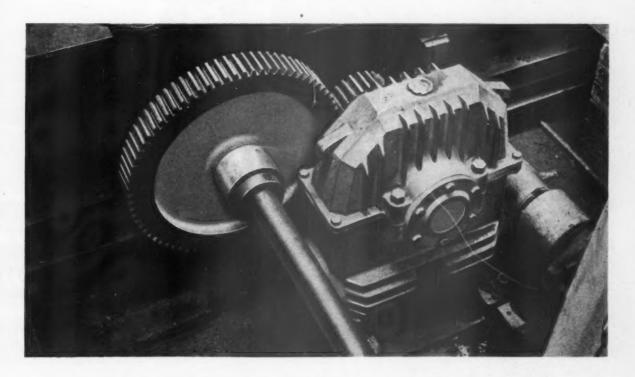
Gear life trebled with Harper S. G. Castings!

These drive wheels for a high-duty conveyor were originally made in cast steel. Wear was very severe and replacements difficult to obtain.

The Chief Engineer says:-

"By changing to Harper S.G. iron the life has been increased up to three times and at the same time the cost of a set of gears has been considerably reduced".

Have you a case where steel forgings, castings or fabrications could be replaced by Harper Castings, with considerable savings and better service? Let us look at your problem to see if Harper foundry technique can help you-it probably can!



Harper quality covers Grey Iron, Spheroidal Graphite Iron (Mond Nickel Licence) and Mechanite castings. Metal pressings, machining, enamelling and sub-assembly work. The word MEEHANITE is a registered trade mark. Also makers of the famous Beatrice Oil Heaters and Harper Housewares.

HARPER CASTINGS



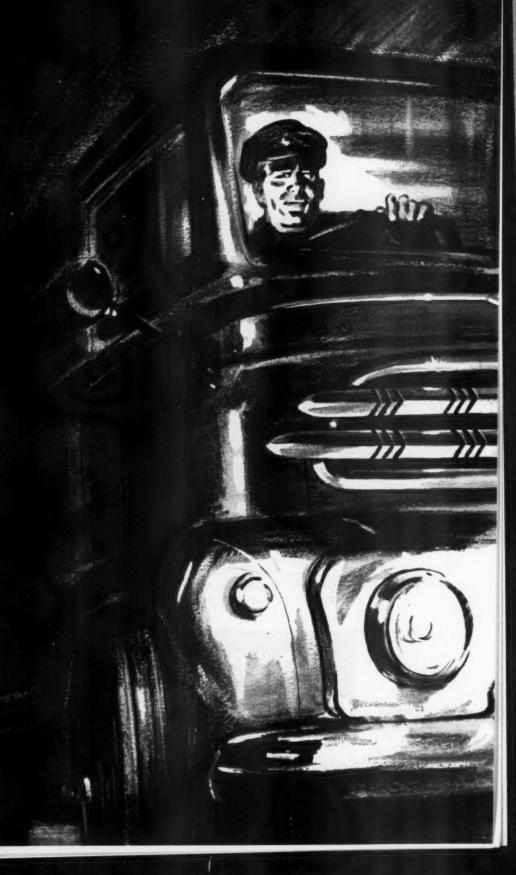
JOHN HARPER & CO. LTD. WILLENHALL STAFFS

Phone: WILLENHALL 124 (5 lines) LONDON, Phone: ABBey 5906/7 MANCHESTER, Phone: BLAckfriers 0295

FOUNDED 1790

H.661

Who's behind



the man behind the wheel?

"A vehicle is only as good as its transmission." Some people might feel disposed to argue about this—but not anyone at the Automobile Gearbox Division of David Brown. We believe it. We live by it.

We make it the basis of our business.

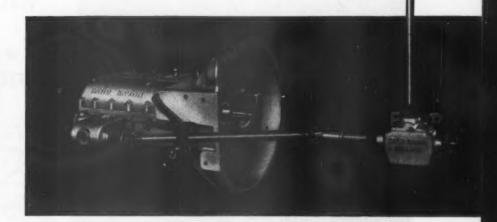
In the days when the internal combustion engine was fighting it out with the horse, David Brown were making gears and gearboxes. We are still making them—'standards' and 'specials'; by

which we mean 'standards' that are special and 'specials' that are extra special.

And we make them in a wider variety than you will find anywhere else in the country.

And so, when the man behind the wheel has behind him the name of David Brown, he can have confidence in the transmission. Every confidence. And this applies whether the vehicle in question is a lorry, a van, a bus, a tractor or a forklift truck.

MODEL 557/480 5 speed. Forward control. Constant mesh on all speeds. Maximum engine torque 480 lb./ft. Approximate weight 470 lb.



DAVID BROWN

THE DAVID BROWN CORPORATION (SALES) LIMITED

AUTOMORILE GEARBOX AND GEAR DIVISIONS, PARK WORKS, HUDDERSFIELD. TEL. HUDDERSFIELD 3500



Rachbone



MULTIPLE DRILL HEADS

* COMPACT IN DESIGN * FIXED OR ADJUSTABLE CENTRE DISTANCES

Hey Multiple Spindle Drill Heads convert Standard Drilling and Boring Machines to High Production Machines permitting drilling of all holes in a component simultaneously, with production rates equal to those obtainable on expensive special purpose machines.

Compact design reduces to a minimum, distance from drill head to machine spindle, whilst careful selection of material ensures an extremely efficient light weight head.

Heads are available with any number of spindles, covering a wide range of sizes

MAXIMUM PRODUCTION ON DRILLING, REAMING, TAPPING AND SPOT

FACING OPERATIONS

ENGINEERING CO. LTD.
COVENTRY PHONE: COVENTRY 88641

We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines, Gear Tooth Rounding Machines, Tapping Machines, End Facing and Centring Machines, Special Machine Tools for High Production.

HRP 1906

Vital links in controlled movement

A body needs muscles to control
movement in very much the same way as a mechanism needs
springs. These vital links take the stress and strain
of every day rigorous use—nature provides the
muscles... SALTER provides the springs.
Two centuries of experience and development
in the manufacture of springs of every type have enabled us to
keep ahead of the ever-changing requirements of industry.

The applications for SALTER springs are wide and varied—from heavy machinery to finely balanced instruments.

For springs with
the highest reputation
and top performance
specify SALTER
all-action springs.



By courtesy of Ericsson Telephones Limited.

SALTER

ESTABLISHED 1760

GEO. SALTER & CO. LTD

WEST BROMWICH

ENGLAND

Speetog Vertical Lift Clamp | Model ST 210

Due to its unique system of linkage, this clamp has two outstanding features. Firstly, the spindle travels in a vertical direction substantially throughout its travel so that it is possible to clamp into or through locating holes. Secondly it can be operated in a very confined space and providing there is 4" available behind the component being clamped, or a total space of 5\frac{3}{4}, for instance between pillars then this clamp can be operated satisfactorily.

Fully Open Position Shows Space Economy. This Clamp Can Be Used in a Confined Space of 53.

Speed Tools Ltd.
VEREKER HOUSE, GRESSE ST., LONDON W.1. Museum 1039/1099.



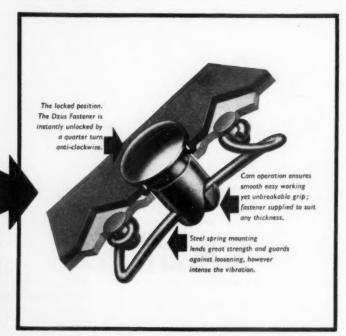
Literature on Request

N.R.P

The fastest fastener...

THE MOST RELIABLE... YET SIMPLE

● Dzus can easily be fitted in solid or laminated materials, regardless of thickness. Dzus have tremendous holding power. Quick in action! Vibration proof! They are indispensable for hinged or removable parts which need frequent inspection, cleaning or adjustment. THE FASTEST FASTENER with the 101 uses for Inspection Hatches and Panels, Engine Covers, Machinery Guards, Fascia Panels, Radiator Grilles and with a variety of uses in the Electronic, Motor Vehicle and Shipbuilding Industries.



DZUS FASTENERS

Write for full details of application to your particular industry to:

DZUS FASTENER EUROPE LIMITED

Farnham Factory Estate, Guildford Rd., Farnham, Surrey Sales Agents in U.K. Thomas P. Headland Ltd. Melon Road, Peckham, London S.E.15

Ribble Motor Services Ltd., use 'Perspex' for lighter, brighter coaches



Interior of coach showing double-glazed roof panel, seat squab corner protectors, driver's screen and introduction panel—all made from 'Perspex'.

Rear of coach showing integrally-printed 'Perspex' publicity panel made by Compra-Plastics Ltd, Hertford.

'PERSPEX'

P707

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

IMPERIAL CHEMICAL INDUSTRIES LIMITED . LONDON . S.W.1



MAGNETIC CRACK DETECTION



The Metroflux Type "S" universal magnetic crack detector is an extremely flexible unit. It is of great value for testing components of large size or awkward shape, and for routine testing of mass-produced components.

IS SIMPLE AND SURE

Even when too fine to be detected by any normal inspection method, surface cracks can be discovered immediately with Metrovick magnetic crack detection equipment. Developed primarily for tests on components produced in the company's own factories, ranging from large forgings to small pinions, this Metrovick equipment is very simple in operation. Use is made of a special magnetic fluid which, after passage of the magnetising current, enables all cracks to be seen with the unaided eye. Most requirements in industry can be met from the standard range of Metrovick crack detectors. Special equipment can, however, be made to order.

Please write for full technical details, and descriptive leaflets.



METROPOLITAN - VICKERS

ELECTRICAL CO LTD TRAFFORD PARK MANCHESTER 17

An A.E.I. Company

N/C201

ARE YOU building a prototype?



Then see our design staff first. They will design your castings for maximum strength, and at the same time reduce complexity and cut costs. That way you'd get cheaper, more sound castings of guaranteed quality and accuracy. Our technical teamwork can tackle all your problems—and solve them.

CASTINGS FROM A FEW OUNCES TO 10 TONS . . .

in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze, and light alloys. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, shell-moulded castings and chill-cast rods and tubes. Continuous cast phosphorbronze bars up to 12 ft. lengths.





NON-FERROUS CASTINGS · HIGH-DUTY IRON CASTINGS PRECISION MACHINED BUSHES AND BEARINGS

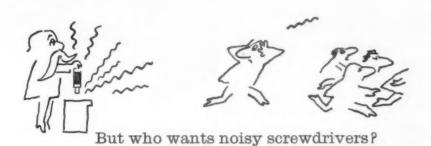
T. M. BIRKETT, BILLINGTON & NEWTON LTD
HANLEY AND LONGPORT, STOKE-ON-TRENT, ENGLAND

Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5/6/7.

LONGPORT, Phone: NEWCASTLE, Staffs 51433/4.



Once upon a time at Exhibitions, Buyers were instantly attracted to the **Desoutter** stand by the noise of the pneumatic screwdrivers.



tea money on research our M.D. sweated and slaved, starved, went hungry, turned white before his time, and finally emerged triumphant, the inventor of the silent Desoutter screwdriver!



Wasn't it Shakespeare who said 'Never make a silent screwdriver—no one will ever hear it'?

Descutter Bros. Ltd., The Hyde, Hendon, London N.W.9. Telephone: Colindale 6346

CBC 322

BESCO ALL STEEL TREADLE GUILLOTINE

24 in. wide \times 16 S.W.G. mild steel 36 in. wide \times 16 S.W.G. mild steel 48 in. wide × 16 S.W.G. mild steel

These treadle guillotines are specially designed to handle the extreme thickness mentioned a unique effort for treadle guillotines. Great strength is obtained from the all-steel construction; the treadles, beams, frames and gauge arms are virtually unbreakable. Built-in hold-down and adjustable gauges with concealed strip lighting if required, give economical, clean and accurate cutting.

Two wide machines to cut

72 in. wide \times 18 S.W.G. mild steel 96 in. wide \times 20 S.W.G. mild steel

complete this versatile range of treadle guillotines.

The 36 in. and 48 in. imes 16 S.W.G. machines can be supplied for motor drive. All sizes are available for pneumatic operation.

Designed and built by . . .



EDWARDS HOUSE, 359-361 EUSTON RD., LONDON, N.W.1 Phones: EUSton 4681 (7 lines) 3771 (4 lines) Grams: Bescotools Londo i NW1 LANSDOWNE HOUSE, 41 WATER ST., BIRMINGHAM, 3 Grams: Bescotools Birmingham 3

7.J.Edwards Ltd



A few words on 'Doc'ility

Docility, according to our dictionary, means 'teachableness'-being able to be told! Now, nobody resents being told, so long as the teller is sufficiently well-informed and, if you don't mind our mentioning it, 'Doc' (our scientific and technical paragon) is remarkably well-informed in matters concerning rubber. 'Doc'ility, may we suggest, is a virtue which it would pay you to acquire: it means putting your problems to 'Doc' and letting him tell you the answers.

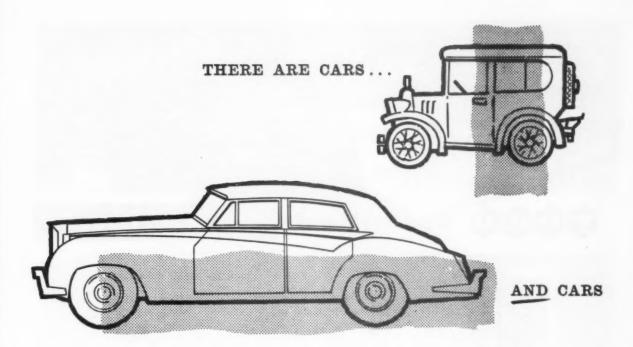
Saves you a lot of time.

Solves your problems

DOC'

KNOWS ALL THE ANSWERS

JOHN BULL RUBBER CO. LTD. (INDUSTRIAL SALES DIVISION) LEICESTER • TELEPHONE 36531



AND THERE IS

CHROMIUM PLATE

AND CHROMIUM PLATE

Efco-Udylite

BRIGHT NICKEL PROCESSES

PROVIDE THE PERFECT UNDERCOAT FOR CHROMIUM

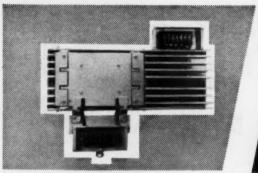
There is no finish for the bright parts of a motor car to equal good chromium plate for brilliance, appearance, ease of maintenance and low initial cost.

The world's best cars are fitted with many parts plated on EFCO-UDYLITE automatic plating machines by EFCO-UDYLITE plating processes.

Pre-eminent in their field, EFCO-UDYLITE design and research continually advance the standards of plating quality.

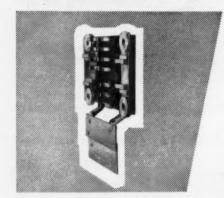


ELECTRO-CHEMICAL ENGINEERING CO. LTD.
SHEERWATER, WOKING, SURREY. Telephone WOKING 5222-7









To ensure ease of operation with "flow-line" production, Ford Motor Company Body Group specified E.M.S. Trolleymaster Collector Track System for vehicle assembly

in their Paint Trim and Assembly Building and in their power tool installations.



EMS ELECTRICAL PRODUCTS LTD., KENILWORTH, WARWICKSHIRE. 'Phone: Kenilworth 658 & 892



Talk to Delaney Gallay about the Heater

We have a very great deal of experience in the design and development of car heating, demisting and air conditioning equipment, together with extensive production capacity. Whilst you are still in the design stage, why not have a chat with us? We will be glad to design and produce something to suit your requirements.

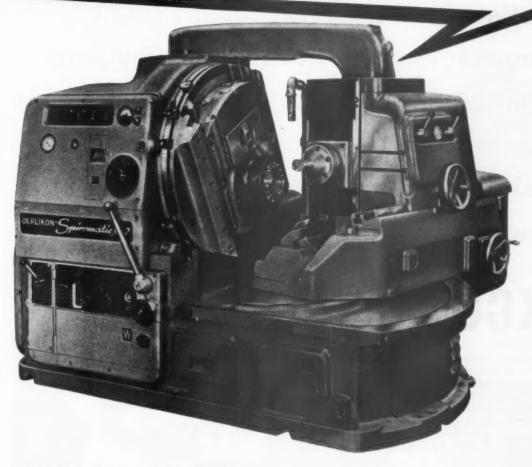
We are also specialists in radiators, tanks and presswork.

Vulcan Works, Edgware Rd, London, Telephone: GLAdstone 2201.

Delaney Gallay LTD

OERLIKON-Spiromatic No.2

SPIRAL BEVEL GEAR GENERATORS, NORMAL & HYPOID



For the highest precision at mass production rates

Please ask for demonstration of this machine in actual production, or on your own blanks on our demonstration unit at our Nottingham demonstration rooms.

VAUGHAN

ASSOCIATES LIMITED

Simple and quick calculations and rapid setting. Operation by single lever. Crown wheels or pinions finished in one loading giving maximum production per capital expenditure with smallest floor space. Max. pitch dia: 21.26". Max. D.P.: 2½". Max. length of cone: 10.33". Number of teeth cut: 5-100.

4 QUEEN ST., CURZON ST., LONDON, W.I

Telephone: GROSVENOR 8362-5

Midland Office: WILFORD CRESCENT, NOTTINGHAM

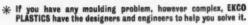
Telephone: NOTTINGHAM 88008

NRP 9048

John Lysaght's Bristol Works Limited

Bristol 2 (Lysaght - De Vilbiss Division) Who were responsible for the manufacture and installation of the entire paint plant congratulate the Ford Motor Company Limited on the magnificent achievement marked by the opening of the new Paint, Trim and Assembly Building at Dagenham







EKCO

PLASTICS FOR INDUSTRY

EKCO PLASTICS LTD . SOUTHEND . ON . SEA . ESSEX Members of the British Plastics Federation

W.P.S.421

British built broaching machines

This photograph illustrates the HP.30 Hydraulic Machine broaching components with a spline broach. The machine is controlled by push buttons placed conveniently at the operator's right hand. Other features include automatic limit switches and variable cutting speeds.

> Standard Horizontal Machines range from 5,000 lb pull-30" stroke to 100,000 lb pull-78" stroke



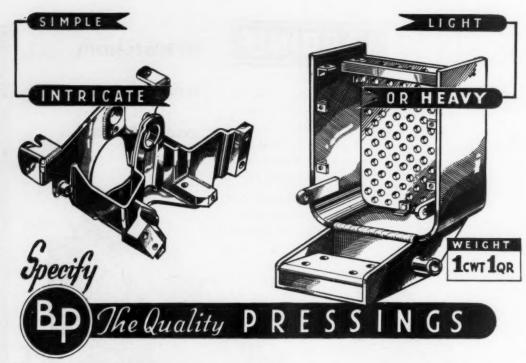


for better broaching



The Lapointe Machine Tool Co Ltd

Otterspool Watford-by-Pass Watford Herts Telephone Watford 31711/2/3/4 Cables Lapointe Watford Also The Lapointe Machine Tool Company Hudson Mass. USA



Manufactured by

B. PRIEST & SONS LTD · old Hill · STAFFS · ENG.

Telephones: CRADLEY HEATH 66501/4

Telegrams: "BOLTS OLD HILL, CRADLEY HEATH"



Manufactured at BRITOOL WORKS, BUSHBURY, WOLVERHAMPTON, ENGLAND.



look at the range of commercial vehicles depending on Hardy Spicer Propeller Shafts and Universal Joints and you will see what we mean.

PROPELLER

HARDY SPICER LIMITED

CHESTER ROAD · ERDINGTON · BIRMINGHAM 24 · ERDINGTON 2191 (18 LINES)

Automotive Division of BIRFIELD INDUSTRIES LIMITED, Stratford House, W.1



Group

"SHAKEPROOF"

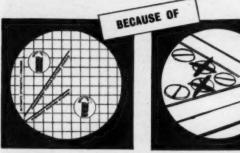
Reg. Trade Mark Nos. B611535

THREAD-CUTTING SCREWS

British Patents Nos. 386895 - 551478



CUT COSTS FOR YOU



GREATER STRENGTH

Hardened for cutting action
... considerably stronger than
ordinary screws ... less breakage in driving or under load,
tighter thread fits.



Mass assemblers find extra strength of "Shakeproof" Thread-Cutting Screws often cuts in half the number or size of required screws . . . saving parts as well as time!



IMPROVED QUALITY

Stronger, tighter fastenings...
fewer rejects ... increased
customer satisfaction ...
greater profits! Every screw
driven is a perfect, dependable
fastening.



FASTER ASSEMBLY

Every replacement of ordinary screws with "Shakeproof" Thread-Cutting Screws is money saved... by elimination of tapping operation which provides quicker assembly.



BARBER & COLMAN LTD BROOKLANDS · SALE · CHESHIRE

Telephone: SALE 2277 (4 lines)
Telegrams: "Barcol" Sale

TRADE MARK

Dealers and Factors enquiries to the following appointed "SHAKEPROOF" stockists:-Nobby Distributors Ltd., 438 Harrow Road, London W.9. Wordrew Ltd., 173 Princess Street, Manchester 1.



ay we do *
your pressing ?

For hot pressings and stampings—accurate well-finished and of consistently high quality—come to Sutcliffe Speakman. We undertake machining where necessary and can work to limits down to '0005". No quantity is too large, no job too complicated, no standard

X

In non-ferrous alloys including aluminium, brass, chromium-copper, cadmium-copper manganese bronze and nickel silver. Also castings in gun-metal, phosphor bronze and heut-resisting nickel chrome alloys.

SUTCLIFFE SPEAKMAN

SUTCLIFFE, SPEAKMAN & CO. LTD · LEIGH · LANCS. Tel: Leigh 94 London Office : 2 CAXTON STREET, WESTMINSTER, S.W.1. TEL: ABBEY 3085



an orchestra are not unfamiliar but the shapes demanded by modern industry are often extraordinary. For all shapes and specifications, Aston nevertheless guarantee the highest accuracy and quality in all their presswork in brass, bronze, copper, aluminium, or tin plate.



FOR PRESSINGS

Makers also of Aston Victor,* Aston Chandelier, and Aston Jack Chains

ASTON CHAIN & HOOK CO. LTD., BROMFORD LANE, BIRMINGHAM 24
Tel.: ERDINGTON 2235/6/7. Grams.: "Chainwork" Erdington 6

8



Use a modern electric motor which will save space—save weight and transport costs—and most important, save on initial cost.

Brook 'C' type motors to British Standard 2960:1958 succeed in obtaining efficient power from smaller frames. The central ventilated design is drip proof and has air deflectors fitted in the endshields to carry a stream of cooling air over the windings while protecting the end turns from damage.

For convincing proof write for List 890 . . . or telephone your nearest Brook Sales Office for free technical advice.

All Brook motors use unified screw threads

Brook Motors Ltd Huddersfield World's Most Respected Motor A very special issue . . right on target!



A comprehensive, magnificently illustrated survey of the world's missiles-from I.C.B.M.s to small infantry types. Full descriptions and histories are given of every non-secret missile, plus photographs, technical drawings and basic data tables. Authoritative articles cover major aspects of missile design, development and use. You'll want to keep this superb special. Get your copy NOW!

From all newsagents is. 6d.



Associated Electrical Industries Limited

INCORPORATING THE MOTOR AND CONTROL GEAR INTERESTS OF BTH AND MAY

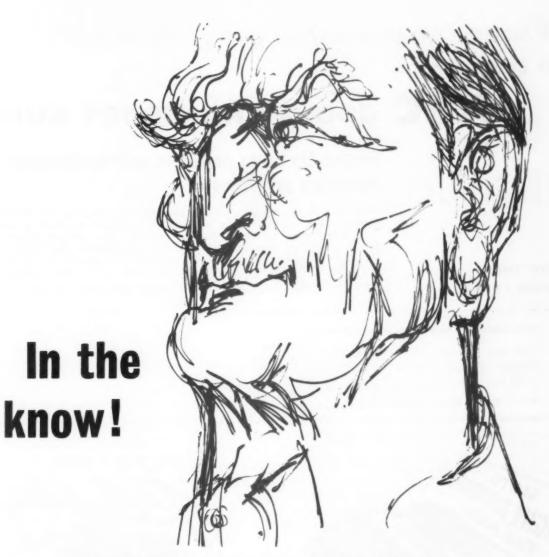


B.S.F., metric, B.S.P., B.A., Whitworth, Unified etc., etc. MANUFACTURING CO. (1938) LTD. BATH . SOMERSET.

inserts are simple, accurate, and effective.

For ferrous applications they are available

Phone: COMBE DOWN 2355/8 Grams: 'CIRCLE' BATH



Naturally I knew that customers want to see vehicles put through their paces before buying them; I knew I could demonstrate cars, motor-cycles, scooters and accessories which can reach an audience of over 7 million on Associated-Rediffusion in the London Transmission Area; I knew, too, that television was inexpensive, and essential today for ensuring my future share of the ever-increasing demand. My dealers welcome full support.

Associated-Rediffusion have prepared specimen campaign budgets from £500 upwards. We will be pleased to show them to you, together with interesting facts about your potential market viewing audience. Just contact Eric Laman (HOLborn 7888) for full details.



ASSOCIATED-REDIFFUSION

Television from London, Monday to Friday

Associated-Rediffusion Ltd., Television House, Kingsway, London, W.C.2. Tel: HOLborn 7888 also 61 Cornwall Street, Birmingham 3. Tel: Central 3041 also Queen's House, Queen Street, Manchester 2. Tel: Deansgate 7744

Whatever your transport query, the answer's as easy as—

ABC GOODS TRANSPORT GUIDE

Finger-tip facts on Home and Continental despatch problems—

With the ABC Goods Guide on your desk, it's no problem to find the nearest, quickest means of despatching any kind of goods—to anywhere in Europe. This indispensable reference covers all the very latest transport facilities. It lists long distance road transport operators (Independent and British Road Services), and gives full details of clearing houses, warehouses, air, canal, ferry and other specialized services. Order your copy of the latest edition now!

POST THIS ORDER TODAY!

JULY-DECEMBER 1959 ISSUE NOW AVAILABLE price 5s. Od.

ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1

Please enter my order for.......copies of the JULY-DECEMBER, 1959, and the JANUARY-JUNE, 1960, issues of the ABC GOODS TRANSPORT GUIDE (at 10s. per set) for which I enclose remittance of...... ADDRESS



Phone: DIDcot 2046.



SEND FOR DETAILS OF OUR FILM "MODERN MALLEABLE"

"MODERN MALLEABLE" (2nd Edition) If you have not had a copy, kindly send us a P.C. We shall be pleased to forward one, post free.

HALE HALE LIMITED DUDLEY PORT STORE

BERKS.

- - ENGLAND

This is



Tecalemit

isn't it?

Tecalemit—Lubrication, of course. You see the Tecalemit target and arrow sign and take the car in for lubrication service. Grease pumps, pipes, lifts, oil dispensers, air compressors—everything's Tecalemit, right down to the grease nipples. So it's simple: Tecalemit stands for Lubrication.

But Tecalemit stands for filtration

In spite of high compressions, greater loadings and higher speeds, modern car engine bearings can tolerate almost anything—anything except foreign bodies in their oil. Thus the Tec-element: an oil filter element of astonishing efficiency. Most leading British engine manufacturers fit Tecalemit oil filters and so recommend Tec-elements as replacements. Sound advice!

But Tecalemit make precision nylon piping too
Nylon piping for automotive uses was once merely
a Good Idea. If only you could use it, it would be
cheap, vibration resistant, strong, supple,
chemically inert and so on. But how could it be
produced to precision limits? Tecalemit found
the answer—a resounding and exclusive technical
triumph. Nowadays such great names as Austin,

Aston-Martin, Ford, Jaguar and Rover use a great deal of Tecalemit extruded nylon piping for fuel lines and vent pipes.

But Tecalemit are famous for oil firing

Oil firing: it takes you out of the automotive field and into the brickworks and kilns. Much tidier brickworks, of course: no heaps of coal and slag. Just pipe runs, control panels, high efficiency and low cost. Oil firing is becoming a major industry in itself—and Tecalemit one of its most prominent names.

But Tecalemit make a thousand other things

Grease guns, power pumps, hose reels, lifts, sprayers, washing units . . . automatic and multiple lubricating systems for machinery and vehicle chassis . . . air cleaners, breathers and ribbon elements (finest air filtration at lowest cost) . . . in fact, an amazing number of things that help keep industrial and automotive machinery washed, pressured, connected, controlled, raised, lowered, filtered.

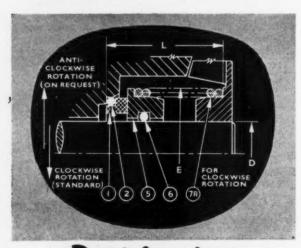
Oh yes—and lubricated. For of course Tecalemit stands for lubrication.



the Authority on Lubrication –
and much else besides!

Tecalemit Limited . Plymouth . Devon





Banish rotary shaft leakage on

- coolant pumps
- hydraulic transmission systems

by fitting

SEALOL OFIEXIDOX MECHANICAL SEALS

Write now for full information to:

FLEXIBOX LIMITED - NASH ROAD - TRAFFORD PARK - MANCHESTER 17 Telephone: Trafford Park 1477 - Telegrams: Flexibox Manchester Telex

Agents and representatives in all parts of the world.

Associated companies in U.S.A., France and Germany.

A useful Book for Garage Proprietors and Managers

AUTOMOBILE EFFICIENCY

By E. T. Lawson Helme, A.M.A.E.T., A.M.I.M.I.

The author of this book claims that a possible outlet for new business lies in developing an organised service of engine tuning and testing. This service may comprise a reception department, a self-contained engine tuning and maintenance department, and a test service for checking the entire installation of any vehicle. The book gives practical advice on the organisation of such a service and explains how to bring it before the public by means of publicity and advertising schemes.

10s. 6d. net. By post 11s. 3d.

Obtainable at all booksellers. Published by:

TRADER PUBLISHING CO., LTD.,
DORSET HOUSE, STAMFORD ST., LONDON, S.E.1



small drills

LARGE DRILLS

insist on



The twist drill par excellence

London Office and Stock

6/9 Red Lion Market, Whitecross Street, London, E.C.1. Tel: MONarch 8771-2

Birmingham Office and Stock

81 Headingley Road, Handsworth, Birmingham. A Tel: NORthern 8211

Manchester Office and Stock 177 Dickenson Road, Manchester, 13.

Tel: RUSholme 7313-4

177 Dickenson Noss.

Scottish Agent and Stockist

John Warden, 50 Wellington Street, Glasgow, C.2.

Tel: City 6994 (2 lines) Grams: Precise, Glasgow THE INTERNATIONAL TWIST DRILL CO. LTD. INTAL WORKS, WATERY STREET, SHEFFIELD 3 Telephone: 23072 (3 lines) Grams: "Fluted, Sheffield"

CAPSTAN AND AUTOMATIC RODUETIONS





GRINDING

DEEP DRAWN



LARGE AND SMALL PRESSING



You can count on GRIFFITHS, GILBART, LLOYD. & CO. LTD.

EMPIRE WORKS, PARK ROAD, BIRMINGHAM 18.

Telephone: Northern 6221.

ANY METAL MY QUANTITY

LONDON BRAND LONDON BRAND LONDON BRAND LONDON BRAND BRAND LONDON BRAND LONDON BRAND The Buyer asks:

Why leadcoated sheets?



- Because they are made by the hot-dipped process which gives a heavier coating, ensuring far more durable protection.
- Because no material is more versatile or more readily fabricated. Soldering, in particular, can be easily carried out.
- Because the steel base used is of the finest quality procurable.
- LONDON BRAND Leadcoated sheets are available for prompt de-livery in a wide range of sizes, and are also supplied in additional sizes to meet special requirements.

A wealth of useful data is offered in our 24-page Brochure. A copy will be gladly sent on request.

LONDONBRAND

TINNED & LEADCOATED STEEL SHEETS

WELLINGTON ROAD . LEYTON . LONDON, E.10

Telephone: LEYtonstone 2281/3

PRESS SHOP AUTOMATION

"Automation" conjures up visions of enormous plants, but to Udal it is a convenient word to embrace the many ways we have devised of doing jobs efficiently and mechanically, for many leading manufacturers and also for quite small concerns. Udal automation stems from a long experience of press spice. from a long experience of press shop problems, so although we take an imaginaproteems, so attnough we take an imagina-tive approach, we have our feet firmly on the ground. We should be happy to discuss automation with you, particularly where press shop applications are concerned You can depend on Udal.

J. P. UDAL, Ltd., Safety and Production Engineers, Interlock Works, Court Road, Birmingham, 12.



COOPERS engineers are available for consultation at all times.

This is a job for Coopers"

And it is in the design stage when the COOPER technicians can be of the greatest assistance. It is their business to know all there is to know about Filters and Strainers. They are prepared to design and manufacture to your own specific requirements.

WASHERS · LAMINATED SHIMS · PRESSWORK



COOPERS MECHANICAL JOINTS LTD., LLANFOIST WORKS, ABERGAVENNY

Telephone: 1043-7

Remote Control Units



All types of Remote Control Units are produced by Gills including Units made to manufacturers specific designs. Famous for twenty years for one reason only—they are probably the best.



PACKINGTON HALL WORKS . LICHFIELD . STAFFS

Telephone: WHITTINGTON 284 & 285

Telegrams: "REMOTE", LICHFIELD

The Modern Diesel

by Donald H. Smith, M.I.Mech.E.

new 13th Edition now available A standard work brought right up to date

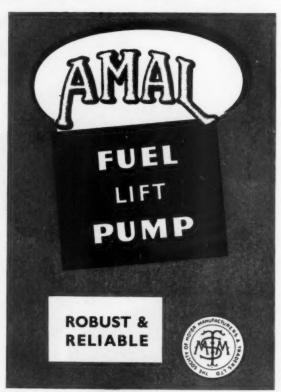
Over 96,000 copies sold

Provides detailed information on the characteristics of high-speed diesel engines and their fuel injection equipment. The latest trends in fuel injection practice, combustion chamber design and fuel and lubricant developments are covered, engines for road, rail, marine and industrial uses are discussed and principal British, American and Continental engines in current use are reviewed.

17s. 6d. net by post 18s. 8d. 288pp. Illustrated. from leading booksellers.

Published by Iliffe & Sons Ltd.

DORSET HOUSE, STAMFORD ST., LONDON, S.E.1



MAL LTD . HOLDFORD ROAD

BIRMINGHAM 6

A.20



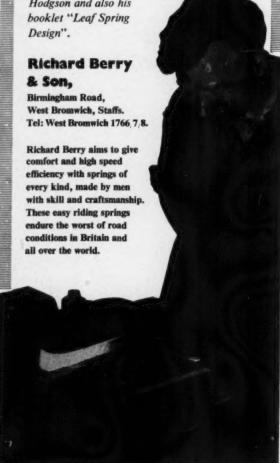
MORSE CHAIN DIVISION, BORG-WARNER LTD. LETCHWORTH, HERTS. TELEPHONE 2:70
Manufacturers of Automotive Transmissions, Torque Converters, One Way Clutches, Morse Chains and Hartcliffe Chains



air suspension steel springs?

British cars are built with a firm suspension for fast cornering on winding country lanes. American cars have a very "soft" suspension to suit their concrete highways. Should our designers copy and use "soft" steel springs with twice as much displacement? Would they be safe on country lanes and would the public buy?

Write for this provocative article by Alun Hodgson and also his booklet "Leaf Spring Design".



The majority of chassis-built cars have chassis frames by-John Thompson including the M. G. A. the Austin Healey and the Austin Gipsy. Equipped with modern plant on production line basis, with some of the largest presses in Europe, John Thompson Motor Pressings Ltd. serves the Automobile Industry with chassis frames and other pressed components. JOHN THOMPSON MOTOR PRESSINGS LTD WOLVERHAMPTON.



A range of popular sizes to suit any T slot or clamping height. No loose parts to lose.

Each size adjustable for height. Any quantity Ex-Stock.



Write or phone for leaflet giving prices, sizes and technical details

WELSH HARP, EDGWARE ROAD, LONDON, N.W.2 Tel: GLADSTONE 0033

Also at: Birmingham-Telephone Springfield 1134/5 S.C.6. Glasgow-Telephone Merrylee 2822

DESIGNERS! THIS IS THE ONE REFERENCE BOOK TO SOLVE YOUR FLUID SEALING PROBLEMS — AND IT'S FREE!

When you design Fluid Seal applications, don't be without this valuable Reference Book issued by Pioneer. Prepared by practical engineers, it includes the latest up-to-date information on Fluid Seal Technology, comprehensive data on a wide variety of applications, how to install correctly with easy-tofollow illustrations for all the various types of seals produced by Pioneer, and a full range of available sizes. The Pioneer Reference Book which comes to you on request, is a practical work for the busy designer and is part of the Pioneer service which includes free advice on any Fluid Sealing problem.



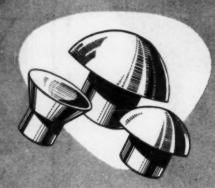
Pioneer

OILSEALING & MOULDING CO. LTD

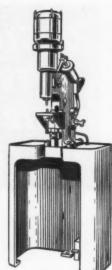
Factory and Head Office:	Cottontree Works,	Colne, Lancs.	Tel:	Wycoller	471	(8 lin

GET YOUR COPY	COMPANY NAME
FLUID SEAL CATALOGUE	ADDRESS
NOW	MARK FOR THE ATTENTION OF

IF YOU USE THESE



We make the widest range of rivet spinners on the market. They are universally used in the manufacture of every type of component for the Automobile Industry, especially, where a neat appearance is as important as a well-formed head. Send us a sample of the product you make and we will advise you on the best machine for the job.



YOU NEED THIS



RIVET SPINNING MACHINES

Illustrated: RS3 V.M.D.A.E. & in. cap. atr operated machine on cabinet base.

TURNER

MACHINE TOOLS LTD 63-68, PRINCIP ST., BIRMINGHAM, 4

Telephone: ASTON CROSS 2244



THE NATION'S REMEMBRANCE

POPPY DAY

Poppy Sellers urgently needed
British Legion · Haig's Fund · Pall Mall · London · SW1

There is nothing to equal the LEAD acid battery for reliability and economy



The technical officers of the Association are always glad to give individual assistance.

LEAD DEVELOPMENT ASSOCIATION, 18 Adam Street, London W.C.2
Telephone: WHItehall 4175. Telegrams: Leadevep, Rand, London

The KING-PIN in yet another production line

10 miles of conveyors

the entire system

in the world's largest car assembly building—
THE NEW FORD PAINT, TRIM & ASSEMBLY PLANT

designed, made and installed by



Materials Handling Specialists

GEO. W. KING LTD.,
ARGYLE WORKS, STEVENAGE, HERTS.
Telephone: Stevenage 440

vital servicing information

... at your fingertips

The fifth volume in this widely-acclaimed series of books, specially prepared for the vehicle repair and servicing industry, includes 24 eightpage service data sheets covering most 1957 and 1958 cars, commercial vehicles and engines. These are supplemented by 28 comprehensive articles on the servicing of proprietary components, ranging from fuel pumps to automatic transmissions. All the sheets are fully illustrated with exploded drawings and photographs. The data sheets are arranged alphabetically under Cars; Commercial Vehicles and Diesel Engines; and Components. There is a glossary of technical terms and conversion and reference tables.

from leading booksellers.



SERVICING GUIDE to British Motor Vehicles

Vol. 5 covering 51 vehicles and components NOW AVAILABLE

67s. 6d. net. BY POST 70s. 312 pp.

Published for "Motor Trader" and "British Engineering and Transport"

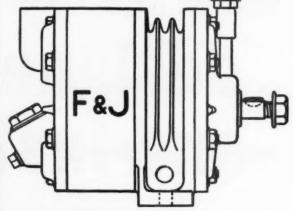
TRADER PUBLISHING CO. DORSET HOUSE, STAMFORD STREET, LONDON S.E.1



CLARKES (REDDITCH) LIMITED SINEW WORKS REDDITCH Telephone: REDditch 100

F BRAKES

E.300 EXHAUSTER



● Very high efficiency ● self contained ● 300 cu. ft.

per hour ● low price ● low weight ● other sizes available.

Vacuum Servos for any Vehicle.

FEENY & JOHNSON LTD.

134/136 EALING ROAD, WEMBLEY, MIDDLESEX
Telephone: Wembley 4801/2 Telegrams: Feejohn, Wembley
DHB/7462



THE HARSHAW CHEMICAL COMPANY, after years of research and development work, was the first to find that a sulphur-free nickel gives greater corrosion-resistance. This fact led to the development of the Harshaw Perflow nickel plating process.

Further research showed that use of the sulphur-free Perflow nickel deposit as a base coating, followed by a bright nickel deposit from a compatible bath, would give a Duplex deposit with a further improvement of corrosion-resistance.

Accelerated tests and outdoor exposures by leading car manufacturers and parts suppliers indicate that the Harshaw Perflow-Perglow Duplexnickel plate is comparable to and frequently better than buffed dull nickel and is unequalled by any bright nickel. This process provides the ideal nickel base for first quality chromium plate.



Write for details of this process to

HARSHAW CHEMICALS LIMITED

ELEANOR CROSS ROAD WALTHAM CROSS HERTS
Tel: Waltham Cross 24957 Grams: Harshaw Waltham Cross

TGA MP.CC

Classified Advertisements

RATE 4d. PER WORD . MINIMUM 4/-

Each paragraph charged separately. Box number 5 words plus 1/-

Advertisements for the November 1959 Show Number issue should be to hand not later than first post 11th November.

(No responsibility accepted for errors)

A.M.I.M.I., City & Guilds, A.M.I.Mech E.,
etc., on "No Pass-No Fee" terms. Over 95%
successes. For details of Exams and Courses in
all branches of Auto, Diesel, Aero, Mechanical
Bing, etc., write for 148-page Handbook—Free.
B.I.E.T. (Dept. 643), 29 Wright's Lane, London,
V.S.

THE Proprietor of British Patent No. 730291, entitled "Method and Means for Balancing Wheels," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A. [5701]

Firm a south Coast area, manufacturing components for the motor industry, requires pesign Draughtsmen and Junior Draughtsmen. Experience of gravity die casting an advantage. Write, stating age, details of experience, qualifications and salary required, to Box 5577, c/o Automobile Engineer. [5702

DESIGN Draughtsman required with experience on Rear Axle Casings for Heavy Motor Vehicles. Attractive salary. Pension scheme. Wolverhampton area. Please write, giving details of age, experience and qualifications, to: Personnel Manager, Box 5578, c/o Automobile Engineer.

Worcestershire Education Committee

COLLEGE OF FURTHER EDUCATION, BROMSGROVE

ENGINEERING DEPARTMENT

Applications are invited from suitably qualified persons for the following full-time appointment.

LECTURER in Management Studies with special reference to Sales and Workshop Organization and Administration.

This post offers the opportunity to be associated with the development of Automobile Engineering Sandwich Courses, and industrial experience in the manufacturing or managerial side of the Automobile Industry would be an added qualification.

The salary will be in accordance with the revised Burnham Technical Scales (1st October, 1959) £1,370 by £35 (4) and £40 to £1,550 per annum.

Application forms may be obtained from the County Education Officer (TS), County Education Office, Castle Street, Worcester, on receipt of a stamped addressed foolscap envelope (S.152). BOOKS

RESISTANCE Welding in Mass Production.
By A. J. Hipperson, B. Sc. (Eng.), A.M. Inst. W.,
and T. Watson, M. Inst. W. The ground covered
by this book ranges from the first principles
of each process to its scientific application in
mass production. Particular reference is made
to design and production requirements. 21s. net
from all booksellers, 22s. 1d. by post from The
Publishing Dept., Dorser House, Stamford Street,
London, S.E.I.

A Multiplication

N

X

T

Precision sum

For automatic and capstan precision parts—in any metal—to your own specifications . . . consult the specialist machinists.

I.F.V., D.A.I., D.I.Arm., A.R.B. Fully Approved.

REPETITION PARTS from the BAR by

Telephone: Broadwell 1115 (4 lines) and 1757



M.C.L. & REPETITION LTD.

POOL LANE . LANGLEY . BIRMINGHAM

BOOKS

STEELS in Modern Industry: A Comprehensive Survey by 29 Specialist Contributors. General Editor W. E. Benbow. An invaluable guide for engineers, designers and draughtsmen; it specifies the steels best used in various engineering applications (bearing in mind the present need for economy), describes their general and special properties and characteristics, and how they may be surface finished for anti-corrosive and other purposes. 42s. net, from all booksellers. By post 43s. 9d. from The Publishing Dept., Dorset House, Stamford Street, London, S.E.I.

CAS Welding and Cutting: A Practical Guide to the Best Techniques. By C. G. Bainbridge, M.I.Mech.E., M.Inst.W. A comprehensive textbook providing practical information on almost the whole range of available gas welding and cutting equipment, methods and processes. Invaluable to the practical welder as well as to those responsible for gas welding and cutting operations involved in the fabrication and repair of industrial equipment. Price 15s. net. By post 16s. 0d. From all booksellers or from The Publishing Dept.. Dorset House, Stamford Street, London, S.E.1.



LONDON W. Kelway-Bamber & Co. Ltd., Room 7, 78, Victoria Street, London, S.W.I. Tel: Abbey 6860. N.E. COAST Fasteners Ltd., 2, Hall Street, Barnard Castle, Co. Durham. Tel: Barnard Castle 3172.

dm 5M 46

COTTON BAGS

FOR SPARE PARTS, Etc.

Walter H. Feltham & Son Ltd Imperial Works, Tower Bridge Road Telephone: HOP 1784 LONDON, S.E.1

MEKELITE



For wall, banch or machine mounting

Catalogue sent free on request.

MEK-ELEK Engineering Ltd. MIT Western Road MITCHAM Surrey

MITcham 3072

MATERIALS ENGINEERS

A new division of the Development and Research Department of The Mond Nickel Company Ltd., London, has been formed to promote the application of nickel-containing materials in modern engineering practice. Applications are invited from progressive engineers having a degree or equivalent qualification, experience in engineering and a working knowledge of metallurgy. Metallurgists with practical engineering experience would also be considered. Pension and assurance schemes are in operation and, in appropriate cases, assistance can be given with housing.

Applicants should write to the Secretary, Development and Research Department, The Mond Nickel Co. Ltd., Thames House, Millbank, London, S.W.1., stating age, experience and salary expected. Mark envelope "Confidential Dev. 29".



FOUNDRIES LTD

The

SPECIALIST FOUNDRY

for

BLACKHEART MALLEABLE IRON

and

HEAT & ABRASION RESISTING ALLOY CASTINGS



for

Automobile and Commercial Vehicles,
Gas, Electricity and Steel Undertakings
Mining and Quarrying Plant
Cement, Brick, Tile and Pipe Works
Heat Treatment Plants
together with many others

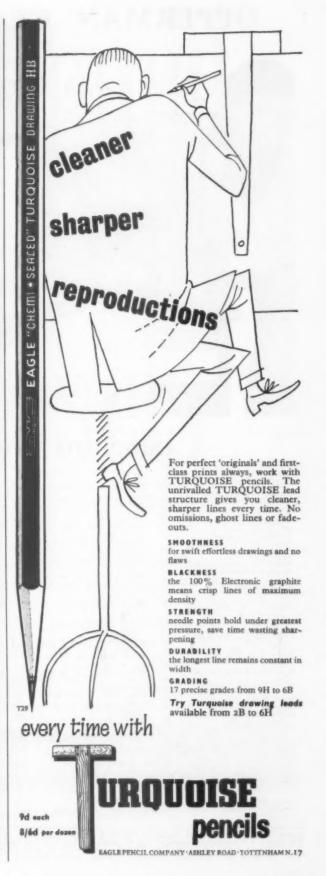
CASTINGS SUPPLIED AS CAST OR FULLY MACHINED

Manufacturers of the PULMAC PULVERISING MILLS for fine grinding

FOLLSAIN-WYCLIFFE FOUNDRIES LTD

LUTTERWORTH NR. RUGBY

Tel.: Lutterworth 10, 60 and 152 Grams.: 'Wycliffe' Lutterworth



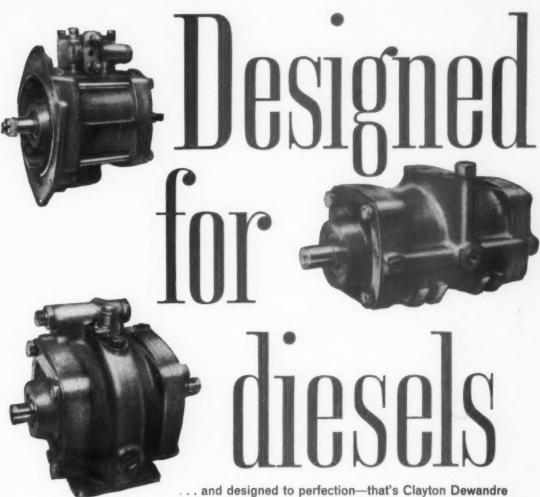
OPPERMAN* GEARS are precision tested



INDEX TO ADVERTISEMENTS

PAGE	PAGE		PAGE		PAGE
A.B.C. Goods Guide 102	Coventry Motor Fittings Co.	Harper, John, & Co. Ltd	81	Philidas Div. of Whitehouse	
A.CDelco Division of General	Cross Mfg. Co. (1938) Ltd. 100	Harshaw Chemicals Ltd Heenan & Froude Ltd	115	Industries Ltd	66
Motors Ltd 61 Adament Engineering Co. Ltd. 35		Tradesan Alfand Tad	9, 11	Pioneer Oilsealing & Moulding	
Adamant Engineering Co. Ltd. 35 Aluminium Bronze Co. Ltd. 104	Dartmouth Auto Castings Ltd. 70	Hay Engineering Co. Lad	84	Co. Ltd	111
Amal Ltd 108	Darwins Group, The 10	High Dury Allows Co Lad	53	Priest, B., & Sons Ltd	112
Angus, George, & Co. Ltd. 34	Dawson Bros Ltd 39 Delaney Gallay Ltd 92	11.65	33		96
Archdale, James, & Co. Ltd. 12	Delaney Gallay Ltd 92 Desoutter Bros. Ltd 89	Ltd., The	15	Ransome & Marles Bearing Co.	
Arc Manufacturing Co. Ltd. 29	Dowty Seals Ltd 63		21	Ltd	36
Associated Rediffusion 101	Drummond - Asquith (Sales)	I.C.I. (Isocyanates) Ltd.	56	Rockwell Machine Tool Co.	
Aston Chain & Hook Co.	Ltd 24, 25	I.C.I. (Plastics) Ltd.	87	Ltd	110
Ltd 98	Dunlop Rubber Co. Ltd 48	Ilford Ltd.	75	Salter, Geo., & Co. Ltd	85
Atlas Copco AB Cover i	Du Pont Co. (United Kingdom)	Iliffe & Sons Ltd	104	Schrader's, A., Son	33
Automotive Engineering Ltd. 40	Ltd 30	International Twist Drill Co.		Selson Machine Tool Co.	
Automotive Products Co. Ltd. 6, 7	Dzus Fastener (Europe) Ltd. 86	Ltd., The	105	Ltd., The	58
Barber & Colman Ltd 98	Eagle Pencil Co 117	Jackson, H., Ltd.	41	Servicing Guide to British	
Benton & Stone Ltd 19	Edwards, F. J., Ltd 90		96	Vehicles	114
Berry, Richard, & Son 110 RIP Chemicals Ltd 16	Ekco Plastics Ltd 94			Sheffield Twist Drill & Steel Co. Ltd., The	12
	Electro Chemical Eng. Co.	King, G. W., Ltd.	113	Shell-Mex & B.P. Ltd.	62
Birkett, T. M., Billington &	Ltd 91	Kirkstall Forge Eng. Ltd	2	Shimwell & Co. Ltd.	
Newton Ltd 88 Birlec Ltd 64	E.M.I. Electronics Ltd 49	Lapointe Machine Tool Co.		Silentbloc Ltd.	106
Borg & Beck Co. Ltd 8	E.M.S. Electrical Products	Ltd., The	95	Simmonds Aerocessories Ltd.	26
Borg - Warner Ltd. (Morse	Ltd 92		112	Skefko Ball Bearing Co. Ltd.	72
Chain Div.) 109	English Steel Forge & Eng.	Lee, Arthur, & Sons Ltd	32	Smethwick Drop Forgings Ltd.	42
B.R.D. Co. Ltd 51	Corpn. Ltd	Lockheed Hydraulic Brake	-	Speed Tools Co. Ltd.	86
British Belting & Asbestos	minist andministrating con some	Co. Ltd.	5	Steel Co. of Wales Ltd., The	4
Ltd Cover is			94	Suffolk Iron Foundry Ltd	80
British Piston Ring Co. Ltd.,	Feltham, Walter H., & Sons	Manganese Bronze & Brass Co.		Super Oil Seals & Gaskets	
The 43	Ltd 116	Ltd., The Marbaix, Gaston E., Ltd	60	Ltd	28
British Thomson-Houston Co.	Ferodo Ltd 31	Marbaix, Gaston E., Ltd	13	Sutcliffe Speakman & Co.	
Ltd	Firth, Thos., & John Brown	Marsden, Samuel, & Son Ltd.	116	Swindon Tool Co. Ltd	98
	Ltd	M.C.L. & Repetition Ltd	116	Swilldon 1001 Co. Ltd	68
Brown, Bavid, Corporation 76		Mek-Elek Engineering Ltd.	116	Tecalemit Ltd	103
(Sales) Ltd., The 82, 83	"Flight" 100 Follsain Wycliffe Foundries	Metalastik Ltd.	65	Terry, Herbert, & Sons Ltd.	47
Bull, John, Rubber Co. Ltd. 90	Ltd 117	Metropolitan Plastics Ltd Metropolitan-Vickers Electrical	1	Thompson, John, Motor	**
	Forgings & Presswork Ltd. 38	Co. Ltd.	88	Pressings Ltd	110
Canning, W., & Co. Ltd 79	Fry's Diecastings Ltd 73	Midland Motor Cylinder Co.	00	Tilghmans Ltd.	22
Cape Asbestos Co. Ltd., The 54, 55	Fuller, Horsey, Sons & Cassell 84	Ltd., The	69	Toledo Woodhead Springs	
Cashmore, John, Ltd. Cover iv		Modern Diesel, The	108	Ltd	20
Churchill, Chas., & Co. Ltd. 67	Gills Cables Ltd 108	Mond Nickel Co. Ltd.	116	Town, Fredk., & Sons Ltd.	60
Clancey, G., Ltd 80	Goulder, J., & Sons Ltd 118	Morris, B. O., Ltd	3	Turner Machine Tools Ltd.	112
Clarkes (Redditch) Ltd 114	Griffiths, Gilbert, Lloyd &	Moss Gear Co. Ltd	57	Udal, J. P., Ltd	106
Clayton Dewandre Co. Ltd.	Co. Ltd 106 Guest, Keen & Nettlefolds	Neill, Jas., & Co. (Sheffield)		Vaughan Associates Ltd.	
Cover iii	(Midlands) Ltd 59	Ltd	18		93
Collier & Collier Ltd 102	(11111111111111111111111111111111111111	Newall, A. P., & Co. Ltd	52	Wellworthy Piston Rings Ltd.	78
Coopers Mechanical Joints	Hale & Hale (Tipton) Ltd 102			Wilmot Breeden Ltd.	45
Ltd 107	Hardy Spicer Ltd 97	Permutit Ltd	74	Worcester County Council	116

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.I., by James Cond Ltd., Charlotte Street, Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd., INDIA: A. H. Whoeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd.; Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: Eastern News Co. Entered as Second Class Matter at the New York, U.S.A., POST Office.



rotary exhausters. Combining robustness and reliability, more than half a million of these vacuum pumps are at present providing the power for braking on diesel-engined vehicles—with an efficiency unequalled in the field of road vehicle equipment.

The range of rotary exhausters manufactured by Clayton Dewandre is wide enough to meet all requirements. Models are available to suit large or small capacity vacuum systems, with mounting arrangements appropriate for the many engine and chassis designs in existence.

Now with important new features:

Aluminium rotors for extra lightness and higher efficiency.

Fibre blades for longer life, reduced wear and higher maximum vacuum.

CLAYTON DEWANDRE CO. LTD.

CLAYTON DEWANDRE COMPANY LIMITED, TITANIC WORKS, LINCOLN, ENGLAND. TELEPHONE: LINCOLN 25272



HEAPER this way!"

"Cashmores hold the stocks and carry the financial burden—whilst I use valuable floor space for production. And, what's more, there's no need for me to worry about losses on redundant stock.

"With their new TELEX service and speedy delivery fleet you can say Cashmore's stocks are my stocks—and that's why it's cheaper all round!"

A call to CASHMORES brings
STAINLESS to your doorstep—in bars,
flats, hexagons, sheets or plate, to
specifications in general use.

CASHMORES

JOHN CASHMORE

ephone: TIPton 2181/7 Telex:

on Office: Artille y Maneions 75 Victoria Street, London, S.W.1. Telephone:

SM/JC.4247/SS